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INCENTIVES IN INDUSTRY

HOWEVER true it may have been in the past that men of science tended to disregard the intangible human element in a situation and to concentrate almost exclusively on the physical factors which they could measure, that charge could not be levelled against those who met at Dundee to take part in discussions at the British Association meeting which touched on the economic situation confronting the nation. The measures which could be adopted to increase productivity and to utilize more effectively the resources of the United Kingdom, and the contribution which science could make to that end, were never considered merely from the purely material or physical point of view. The human factor was given its full weight, and even industrial or productive efficiency was estimated not solely from the mechanical aspect but also in the light of the physiological and psychological demands which were involved in the effort required from men and women.

That was, of course, particularly true of discussions in Sections I (Physiology) and J (Psychology), but it also characterized some of the general discussions as well as various joint discussions of general interest such as those on "Man and the Machine", on selection for management and on incentives in industry. In all these there was manifest more awareness of the outlook and needs of ordinary men and women than has been apparent in some of the recent manifestations of Government policy to deal with the present situation. A striking example is to be found in Dr. R. E. Lane's fine contribution to the discussion on man and the machine, which showed a clear conception of what is involved and needed in the sphere of human relations in industry whatever form of organisation may be adopted. Nationalization alone, as the brief experience of the National Coal Board is already tending to show, is no sufficient solution, and no economic and financial system of incentives can dispense with the need for further work in this field of human relations. All possible means must be taken to eliminate the suspicions and misunderstandings which have hindered co-operation in the past, and to promote both an atmosphere and an outlook which make for co-operation and mutual confidence.

That is the first condition of increased productivity, and the symposium on incentives in industry arranged by Sections F (Economics) and J (Psychology) on September 2 demonstrated the crucial importance of such personal satisfactions. Dr. J. A. Bowie, in opening this discussion, urged that the psychological conditions are even more important than the physical ones. Incentives as commonly conceived may even offer no real contribution in the battle for output, and he thought it possible that no system of incentives would work well or permanently within the limits of the present system. What is needed is a sense of participation, which may only be secured by radical changes in factory life dispelling the present misunderstandings and distrust. A new psycho-sociological approach and further research in the field of incentives might make most important contributions

in securing the satisfaction in work and sense of participation which would provide the real remedy for so much industrial unrest and low productivity.

Much the same point of view was urged by Mrs. W. Raphael, of the National Institute of Industrial Psychology, from the results of attitude surveys covering 15,000 workers of all grades in industry, conducted by the staff of the Institute in recent years. Financial incentives are not all-important, although they may be very significant if the workers do not consider their pay to be 'reasonable' or 'fair'. Satisfaction in the job itself is important among managerial and skilled workers, but less often in skilled and unskilled work, and can be increased by good vocational guidance, selection and training for the job. Participation, the sense of mattering to the organisation, and knowing about and possibly influencing its activities are important incentives which should be stimulated by such methods as joint consultation in its widest sense.

The National Institute of Industrial Psychology has obviously experience which could be of great value to the numerous joint production committees and to other bodies concerned with joint consultation as well as to management, including those organisations supporting research in the management field. That experience will no doubt be fully available to the British Institute of Management; and a body such as the National Staff Administrative College may well be expected to assist in the wider and wiser study and use of incentives throughout industry. Mr. Dennis Chapman's review of the factors that make for harmonious relations between working groups indicated other fields for research. Like Mrs. Raphael, he directed attention to the importance of environment, while Mr. C. Madge, of "Mass Observation", again emphasized that financial incentives are only one factor in a complex situation. Payment by results and bonus systems are only really successful when applied by managements who recognize this limitation. Few people work as hard as they are physically capable of doing, and restriction of output may be both conscious and unconscious, originating sometimes in the fear of unemployment through over-production. Moreover, there are demands for leisure, for less responsibility and for easier work, which can be as real and potent as the demand for material goods.

Mr. Madge urged that the principal way to increase production is by improvements in machines and in the physical organisation of the factory; but it is easy to see how, at a time when the worker finds it difficult to exchange wages or salaries for the material goods he desires, the pulling power of the demand for leisure and easier work can easily become more potent, even if we leave out of account the effect of six years of war. The balance will most certainly not be redressed by exhortation and organisation alone. As regards the building industry, which is among the least progressive and most wasteful of British industries, neglectful of research and indifferent to innovation, the scale of values of the operatives differs in important respects from that of many other industrial workers. To most of them a steady guaranteed wage is more important than higher but less regular earnings obtained either through a rise in rates or through payment by results. Most of them, too, are unwilling to accept increased payment under a system which, in their view, would inhibit or destroy other strong motives such as pride in craftsmanship and the sense of comradeship. Miss N. M. Davis's contribution dealing with this industry was of special interest.

It is clear that here as elsewhere the problem is really one of building co-operation into our whole industrial system, and in an industry such as the building industry this is the only means of achieving the immediate results that are imperative. Technical improvements resulting from research may make large contributions to increased efficiency in the long run, but for immediate results it is upon efficient management as well as a new approach to incentives, conditions of employment and welfare that we must rely.

There is, in fact, urgent need for a scientific approach to the problems of incentives and human relations, both in private and nationalized industry; and the need is the more imperative because whatever shortcomings may be urged against private industry, there is no evidence that industry directed by the State itself would be either more efficient or freer from labour disputes and unrest. The evidence so far indicates a conspicuous failure of the idea of the public interest and a concern for the welfare of the whole community to permeate the rank and file of the employees of nationalized industry. This, however, is our fundamental need, and until it is true of industry generally, whatever the form of its organisation, we are unlikely to see the full productive effort that is required.

A thoughtful paper on this point has been contributed by Dr. Ordway Teed on "Public-Mindedness through Co-operation" (*Ann. Amer. Acad. Pol. and Soc. Sci.*, Nov. 1946). Dr. Teed sees no quick and easy way to industrial peace, but he maintains firmly that collective bargaining as the beginning of responsible constitutional government in industry is the primary public interest. Equally, he insists that the pattern of joint management–labour working arrangements must be voluntary, and he develops his argument on similar lines to Colonel Urwick and Mr. C. C. Renold in Great Britain.

The conception of the common interest requires, however, the development of much more effective means of informing all parties of the reasons for decisions and policies, so as to secure their consent and support, and there is room for inquiry into the best means of achieving this. We cannot wisely assume that the production committee or works council is the only, or even the best, means of doing so. Moreover, when we have succeeded here, we may find that the whole order of importance of incentives is changed. We may, in fact, find that though the financial incentive needs to be supplemented by others, which it is the urgent duty of management to explore and apply, such as pride in the finished product and a knowledge of its value to the country,

the possibilities of group leadership and competition, and the latent desire for self-expression, it may, subject to appropriate safeguards, afford the most effective and compelling motive of all.

One aspect, often forgotten, is well brought out in some of the inquiries already made; it is not for the monetary reward itself that the financial incentive is important, but for the satisfaction which that monetary reward makes possible. What needs to be remembered is that once the monetary reward is sufficient to meet elementary and basic human needs, it makes possible the satisfaction of other needs according to individual choice. It is partly because controls and shortages are preventing such satisfactions that the financial incentive has proved ineffective. But, however effective the service motive may become, no alternative to the financial incentive which offers the same opportunity and freedom of choice has yet been proposed.

Prof. H. S. Kirkcaldy's reminder to the planner, in his "Industrial Relations in Conditions of Full Employment" (Cambridge University Press, 1945), that the ultimate judge of essential liberties is the individual citizen or worker himself is equally pertinent in this matter of incentives, and in so far as the financial incentive permits the exercise of the freedom of choice it should not be discounted so severely as in the discussion at Dundee. The point is one that the Government, too, has widely disregarded. Incentives need to be tangible and easily visualized by the worker; when, as at present, Government policy has deliberately removed both the 'carrot' and the 'stick', it is not surprising that production lags.

The effort to build up co-operation effectively which, as Prof. Elton Mayo has remarked, is the fundamental problem we face to-day, must take full account of this aspect of freedom. It accentuates the importance of the question of the communication of knowledge and information; both the capacity of an individual to communicate his feelings and ideas to another, and that of groups to communicate effectively and intimately with each other. Much that was said at these discussions at the British Association's meeting at Dundee confirms the correctness of Prof. Mayo's view that social study should begin with careful observation in this very field. Here our civilization is most defective, and although we have reached some appreciation of the fact that collaboration in an industrial society cannot be left to chance, we have yet to realize that there is no simple or rapid solution. Patient, pedestrian study of the wholly neglected problem of the determinants of spontaneous participation is, as Prof. Mayo observes, the line of advance, and imperative as is the application of scientific method to the study of the social situations involved here and elsewhere in industry and in society, the scientific approach offers no promise of immediate solutions. The British Association discussions should not only lead to the more widespread study of these questions, but should also assist a more sober and realistic appreciation of what is involved and the conditions of success, and above all the importance of extending and developing both technical and also social skill and human co-operative capacities. It would be disastrous to rely entirely on the production committees and works councils without exploring this whole field of the techniques to determine the effects of action in the social field, the means of securing spontaneous co-operation alike of groups and of individuals. The problem of incentives is only one facet of the larger one of industrial relations, which in turn is, as we are now realizing, part of that of the relations between groups and individuals in the society which constitutes the whole nation. Objective inquiry there must be, and action and policy must increasingly be based on the results of such inquiry and the techniques developed thereby, at the level of Government, in the factory, the workshop and the laboratory. Ultimately it is the task of management to use that knowledge and technique to serve the common ends, and no amount of exhortation and precept can be a substitute for the effective leadership which is the mark of good management and also of good government.

NEWTON AS CIVIL SERVANT

Newton at the Mint

By Sir John Craig. Pp. viii+128+4 plates. (Cambridge: At the University Press, 1946.) 7*s*. 6*d*. net.

IN 1696, when he was fifty-three years of age, Newton was appointed warden of the Mint, and in 1699 he was promoted to the master's place, which he held to the date of his death. The last thirty-one years of his life were thus passed in a public service which, if not as a whole arduous, yet occupied much of his time and was, on occasion, vexatious and exacting. So much can be found in any biography, but hitherto there has been no detailed account of this aspect of the great man's life, nor, indeed, are the necessary sources within reach of all.

Sir John Craig, who now comes forward to fill the gap, is particularly fitted for the task, having himself long been deputy master of the Mint, where he has had access to most of Newton's writings on matters concerning coinage. He has already, with Prof. Shirras, examined Newton's monetary theories in the *Economic Journal* of June 1945, although without reference to certain papers now available to him. In the little book before us he explains the very complicated history of the coinage of Britain, in particular the recoinage round about the beginning of the eighteenth century; the structure and personnel of the Mint, including such matters as the respective duties of the warden and the master; the many technical problems of producing coin at the period in question and the fixing of the intrinsic value; and, in particular, Newton's part in it all.

The book is written from the point of view of one familiar not only with the manufacturing problems of coinage but also with the economics of metal currency and of foreign exchange, which makes it in parts tough reading for the cloistered physicist. All the more does it show that Newton was thoroughly competent in financial matters, of which he wrote with his usual incisiveness, as exemplified, for instance, by the following passage.

"'Tis mere opinion that sets a value upon money; we value it because with it we can purchase all sorts of commodities, and the same opinion sets a like

value upon paper security. . . . All the difference is that value of gold and silver is set upon their internal substance or matter and therefore is called intrinsic, and the value of paper security upon the apparent form of the writing and therefore called extrinsic, and that the value of the former is more universal than that of the latter."

He was also, it appears, a good organiser and, surprisingly enough, tactful and successful in his personal relations, but he was "averse from all novelties" and made no notable innovations. How different, in every respect, is his record as a Civil servant from his record as a man of science.

The Great Recoinage which began early in 1696 is usually represented as a national melioration, for which Newton was largely responsible. For example, Mr. George Roberts, one-time director of the United States Mint, says of it, "unquestionably it was a great reform, creditable to all who had any part in it". Alfred Marshall termed it "the necessary but drastic remedy, which the Government was applying in 1695 for the corrupt condition of the coinage". Sir John states bluntly that it was a social crime and, in any case, the principles had been determined before Newton's first appointment, so that he was only the agent for putting into practice decisions already reached. The difficulties with which he had to contend in this capacity, including the constant disputes between the garrison of the Tower, in which the Mint was situate, and the personnel of the Mint; the prosecution of coiners; and the trouble with the standards, described with many other concerns in a chapter entitled "All Kinds of Vexations", are clearly depicted. A matter of considerable general interest that occurred towards the end of Newton's life was the affair of "Wood's halfpence", still remembered from Swift's attacks in the "Drapier Letters". Apparently the coinage in question would have been better in all particulars than any issued before in Ireland, but in view of the unjustified, but violent, agitation against it, it was withdrawn. "The English Government had no inclination to do unpopular good by force." Newton's part in the whole affair was, of course, purely technical.

The student of Newton will find in this book many personal details of general interest. Typically enough, we find Newton, who was always a man of his hands, carrying out assays himself, no doubt to see how it was done, since, apparently, he made no improvements. Sir John concludes that Newton wrote at tremendous speed, which is consistent with his habit of perpetually redrafting, of which many examples are given. Anyone who has studied the catalogue of the Sotheby sale of Newton papers in 1936 will find no difficulty in accepting this conclusion. The author opines that these pains and scruples and afterthoughts in drafting may have fostered Newton's lifelong aversion from publication: perhaps we might rather say that the redrafting and the shrinking from publication were both symptoms of his horror of controversy, to which ambiguous passages might give rise. Not known to everybody is the fact, here recorded, that Newton changed the Royal Society meeting day from Wednesday to the present Thursday, because Wednesday was the Mint's day for paying out coin.

Enough has been said to make it clear that this is a book which everyone seriously interested in Newton must possess. It is embellished by many a pleasant turn of phrase, as when the author refers to Halifax's association with Catherine Barton as "a morganatic alliance without benefit of clergy", or when he says of a phrase in an Act "it must signify something, as an absurdity of Parliament was, legally, unthinkable, but each learned man favoured a different something". The general merit of the little work being fairly acknowledged, it will not, I trust, appear ungracious to point out a few minor deficiencies. The author would seem not to have consulted, or, at any rate, made full use of, either De Morgan or Edelston, and when he mentions the "famous report of 21 September 1717", which was long a weapon in the controversy between the bimetallists and the champions of the gold standard, he does not give the references where the ordinary reader can find it and other reports, namely, the "Macclesfield Correspondence" and "A Short Essay on Coin"; nor does he quote McCulloch's "Select Collection of Tracts on Money" or refer to Horton's "Silver Pound". In general, the references which the serious student needs are lacking. "Mr. Gyre's house" at Pudlicot should, according to the reprint of the letter in De Morgan, be "Mr. Ayre's house", which sounds more probable. To say of the prize of £20,000 for the longitude that "one half of this was won by John Harrison in 1726" is so manifold an error that one can only refer the reader to R. T. Gould's "The Marine Chronometer". The reference to Brewster in this matter is wrongly given. I doubt if the statement that Newton was knighted to attract voters can possibly be made good. But these are trifles, and we would wish to end on a note of thanks to Sir John for the learned labour which he has put into this informative little work. E. N. DA C. ANDRADE

GENETICS AND MAN

Genetics, Medicine and Man

By H. J. Muller, C. C. Little and Laurence H. Snyder. Pp. xi+158. (Ithaca, N.Y.: Cornell University Press; London: Oxford University Press, 1947.) 2.25 dollars.

THIS book presents the subject-matter of the Messenger Lectures delivered in 1945 at Cornell University by three geneticists, each outstanding in his own particular field. The lectures were addressed to a general audience and dealt with (*a*) the fundamental principles of genetics (H. J. Muller), (*b*) parental influence and growth of individuality (C. C. Little) and (*c*) the special genetics of man (L. H. Snyder).

As was to be expected, Prof. Muller presents a most attractive account of genetical fact and theory, simple yet meticulously accurate in statement, clothed with pretty notions and bedecked with stimulating ideas. To him the dance of the genes is a spectacle to be seen and an entertainment to be enjoyed. He has a great facility for enabling an audience to share his pleasure. To know or to hear him is to appreciate the excitement of adventure that can be encountered in the genetical field and the quiet joy that comes with an understanding of its principles.

Dr. Little is another example of the relative importance of the apostle in the attraction of interest and attention to the science which he represents. Here is the picture of a man who turned away from the glamour and power of high positions of academic and political eminence to return to the quiet aloofness of a laboratory. The account which he gives of the

discoveries made by himself and his colleagues in the Roscoe B. Jackson Memorial Laboratory at Bar Harbor reveals in the clearest possible fashion that the greatest gifts that science can give to a man are intellectual honesty of the highest order, an emotional serenity and a great faith in the expanding dignity of mankind.

Prof. Snyder is a recognized leader in the field of medical genetics, to which subject he himself has made many notable contributions. There is none better qualified than he to show the place of genetics in medicine, its importance in the search for etiological factors and its limitations. In this brief narrative he easily succeeds in displaying the role of the gene in the causation of human defect and derangement.

A course of such lectures by such men could not do otherwise than demonstrate in the clearest possible fashion the important bearing that genetic fact and theory have upon a wide diversity of human and social interests and activities.

This book will claim the attention of all geneticists, since all will wish to see how these three colleagues of theirs tackle the problem of making genetics attractive to the general audience and reader. It can be strongly recommended to practitioners of medicine and to men of science other than biological; in fact, to all who seek an easy yet strictly accurate account of what genetics has become and of what it can promise in application. F. A. E. Crew

THE PROCESS OF PUBERTY

Adolescent Sterility

A Study in the Comparative Physiology of the Infecundity of the Adolescent Organism in Mammals and Man. By Assoc. Prof. M. F. Ashley-Montagu. Pp. ix+148. (Springfield, Ill.: Charles C. Thomas; Toronto: Ryerson Press, 1946.) 3.50 dollars.

IN "Adolescent Sterility" Dr. Ashley-Montagu assembles an impressive body of facts which show that puberty in the female is not a sudden assumption of the capacity to reproduce, but a slow process of development during which the ovaries and the accessory reproductive organs develop their rhythm of physiological activity. Ovulation, and especially ovulation as a fairly regular phenomenon in the sexual cycle, is not established until the end of the pubertal phase. Consequently it follows that conception is unlikely to follow mating during a mammal's first sexual cycles, and that a period of what is called "adolescent sterility" is associated with the process of puberty. Dr. Ashley-Montagu defines the term as the interval of time from the first œstrus during which, in a given population, a majority of normally developing individuals are incapable of conceiving and remain sterile, while those which do conceive either suffer a high mortality-rate or exhibit a high proportion of abortions or miscarriages. This latter effect is attributed to the fact that at the time of the first ovulations the body "as a whole" may not have reached a mature enough state to sustain the process of reproduction.

Dr. Ashley-Montagu supports these generalities with experimental observations that have been made on mice, cows, rhesus monkeys and chimpanzees, and with a number of statistical observations about human reproduction in different parts of the globe. These show that the percentage sterility and the average interval between marriage and the birth of the first child are greater in women under than over the age of twenty, and that "prior to the age of 20 years the process of childbearing constitutes a hazard to the life of both mother and child, which increases in proportion to the youthfulness of the mother and decreases to a minimum at maturity".

Dr. Ashley-Montagu has personally contributed little to the body of evidence which he reviews, for he is an anthropologist, not a physiologist. His wide reading, however, has provided him with an extensive knowledge of a field not quite his own. Unfortunately it is also reflected in a laboured treatment of the subject, in excessive quotation, and in the discussion of topics which are somewhat remote from the main theme. This is a drawback in a short book; but students will no doubt willingly put up with this fault in return for the able summary which Dr. Ashley-Montagu provides. S. Zuckerman

OCEANIC BIRDS: A PICTORIAL SURVEY

British Sea Birds

Written and illustrated by C. A. Gibson-Hill. Pp. 144 (48 plates). (London: H. F. and G. Witherby, Ltd., 1947.) 18*s*. net.

THE author selects twenty-four of the most oceanic of the sea-birds which breed in the British Isles, and makes them the subject of a series of thirteen short essays. There is nothing original about these essays—they are the result of a photographic tour made by the author in 1946 around the principal accessible islands and coast sites, and in one brief summer of bad weather the author makes no claim to having discovered any new facts. Yet he has managed to convey to the reader something of the charm of the islands and their avian inhabitants. He has drawn, with acknowledgments, upon the original observations published by other workers, including the recently published work of American ornithologists, who made progress denied to British observers during the war years. This information is presented in a straightforward style, and in a large type that is refreshingly easy to read. Line-drawings of the heads of related species showing seasonal plumage changes are quite useful, although some are redundant because the photographs show these differences more clearly. The elementary life-history of each bird is sketched out—breeding, feeding and migration, and a note added on the derivation of the common name.

Considering the high price of this book, and the interest that is taken in Britain in sea-birds, the text is disappointingly brief. Distribution and field characters and notes on rarer species are squeezed into a concluding chapter with distribution maps, but these are not as accurate as one could wish. The photographs, taken with a miniature camera, speak of the patience and skill of the author, and although they suffer somewhat from over-enlargement and from being grouped together without relation to the text, they are most attractive. One has the impression that the author set out to make a book of photographs of sea-birds, and decided afterwards to expand the captions into brief chapters. As an advertisement or pictorial introduction to the study of British sea-birds the book is of value to the beginner.

R. M. Lockley

The Cult of the Superman

A Study of the Idea of Heroism in Carlyle and Nietzsche, with Notes on other Hero-Worshippers of Modern Times. By Eric Bentley. Pp. xxiii + 277. (London: Robert Hale, Ltd., 1947.) 12*s.* 6*d.* net.

THIS is a discussion of the cult of the hero considered as the shaper of human destinies; a cult started by Carlyle, developed by Nietzsche and continued by Wagner, Bernard Shaw, Spengler, Stefan George and D. H. Lawrence. The last three, though Mr. Bentley does his best to polish them up, are just dim. Shaw, who is anything but dim, is only a hero-worshipper spasmodically in his Wagnerite moods. Wagner had great influence in his day, but still is only a lightweight. Were even the first two heavyweights? Mr. Bentley thinks they were or he would not have written this witty and provocative book. They have been labelled proto-fascists; but the label, even if it is appropriate, does not make their ideas negligible. Fascism takes account of elements in human nature which liberals and rationalists have refused to see. Carlyle and Nietzsche did see that mass-production of machines and the mechanization of the human masses was not the road to any paradise, capitalist or proletarian. They did foretell more about the twentieth century than any of their contemporaries. Marx and Engels unaccountably omitted to predict Lenin and Stalin; Carlyle and Nietzsche made a very good shot at them (not to mention Hitler, Mussolini and others). But, as Mr. Bentley shows, the doctrine of the hero has always been confused and inconsistent, and always been propounded by those whose attitude to life is ambivalent. Mr. Bentley himself is ambivalent towards his subject. He thinks that this sound and fury signified something but finds it difficult to explain what. He concludes with the mild observation that democracy needs leaders, an aristocracy of talent; a conclusion that would infuriate Carlyle or Nietzsche, who did not admire the characteristic democratic leader of the American or British pattern.

A. D. R.

Précis de dermatologie

Par J. Darier, A. Civatte et A. Tzanck. Cinquième édition par A. Civatte. Pp. v + 1,152. (Paris: Masson et Cie., 1947.) 1,700 francs.

THE appearance of a fifth edition of Darier's "Précis de Dermatologie" is an event of importance. The last edition appeared in 1928 and has long been exhausted. This book has become in France, where dermatology is an art less confined to the specialist than it is in Britain, part of the library of nearly every student.

The title is misleading, as the scope is more nearly that of a text-book than a précis. It is intended as a guide to diagnosis for the practitioner and as an introduction to dermatology for the student. General principles of treatment are indicated, but detail is omitted.

The book is divided into two main parts. The first classifies the skin diseases according to morphological appearances; the second part deals specifically with diseases grouped according to causal agents.

This is a complete guide to dermatology without omission of the rarities, and it is a book which no specialist need disdain.

The new edition has been edited and brought up to date by Dr. Civatte since the death of Darier. He is to be congratulated on his work, which includes all the recent advances in the subject in diagnostic measures, treatment methods, etc. This has been achieved without altering the fundamental design set by Darier. Many good new illustrations have been added.

I do not hesitate to say that this work has no equal in the English language, and that the new edition will consolidate its high reputation in the exacting school of French dermatology. JAMES MARSHALL

The Theory of Functions of Real Variables

By Prof. Lawrence M. Graves. Pp. x + 300. (New York and London: McGraw-Hill Book Co. Inc., 1946.) 20*s.*

THE exposition of a mathematical subject in its early stages of development is apt to require a bulky volume; the appearance of this concise treatise, covering so much ground, would consequently suggest that the theory of functions of real variables is now coming to maturity. Conciseness is partly achieved by the extensive use, especially in the earlier part of the book, of the symbolism of mathematical logic. In order to accustom the reader to the use of this symbolic method, many statements in the earlier chapters are given in duplicate, first in symbols and then in ordinary language.

The subjects covered in three hundred pages include the following: the real number system, sets of points, limits, the Riemann integral, uniform convergence, implicit functions, the Lebesgue integral and the Stieltjes integral. The exposition is careful and thorough, but so condensed that the beginner would find its perusal far from easy without the assistance of lectures or of a tutor: indeed, the author suggests as much in his preface.

It seems strange that, in his limit notation, the author makes use of the obsolete sign of equality, and not of the arrow-head as introduced by Leathem and Bromwich.

T. M. M.

Physical Chemistry for Colleges

A Course of Instruction based upon the Fundamental Laws of Chemistry. By Prof. E. B. Millard. (International Chemical Series.) Sixth edition. Pp. ix + 682. (New York and London: McGraw-Hill Book Co., Inc., 1946.) 22*s.* 6*d.*

Fundamental Principles of Physical Chemistry

By Prof. Carl F. Prutton and Assoc. Prof. Samuel H. Maron. Pp. x + 780. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1944.) 25*s.* net.

THESE two books are excellent examples of modern American texts on physical chemistry. The continued usefulness of the former is attested by the five previous editions, while the latter is a new work. Both make a thermodynamic approach to the subject and cover a considerable amount of ground. Although stated to be for beginners and designed for a single year's work, they do not confine themselves to the elements of the subject (which are covered very agreeably); they take in their stride such complex affairs as the Debye–Hückel theory, activity coefficients, the third law of thermodynamics, rotational spectra, modern formulations of reaction kinetics, etc. Remembering his own experience as a teacher, it is something of a mystery to the writer how the American student of chemistry and chemical engineering manages to digest all this in so short a time. Both books are well provided with problems.

J. A. V. BUTLER

GEOLOGY AND THE FUTURE OF COAL SUPPLIES

IN the presidential address to Section C (Geology) of the British Association, delivered at Dundee on September 1, Dr. Murray Macgregor stressed the vital need for closer co-operation between the miner and the geologist for the better-planned exploitation of the coal resources of Great Britain; his address was followed by a discussion on the future prospects of those supplies.

In opening the discussion, Prof. H. G. A. Hickling suggested the importance of attention to the various classes of coal and their most effective use, rather than the estimation of total reserves. Even with the wasteful usage of former years, the total supply is unlikely to approach exhaustion within any period for which it is reasonable to plan at this time; but it is less certain that one can be equally optimistic regarding some of the most valuable varieties. The first-class coking-coals, the anthracites and some other classes have hitherto been obtainable only from very limited areas in Great Britain, where they have been heavily wrought and the reserves greatly reduced. It is consequently a matter of major importance whether the remaining reserves are likely to yield a greater or smaller proportion of such types. Any useful forecast must be based on a knowledge of the distribution of existing coal types and its causes.

Coals vary in their characteristics from two main causes: first, from variation in the original deposit in respect of the contributory plant material, its mode and extent of decay and the nature and quantity of associated mineral matter; and secondly, as the result of the varying extent of subsequent alteration under geological influences. Regarding the first, the long-familiar division of coals into 'brights' and 'hards' corresponds broadly to those ('brights') which have been formed mainly from pieces of organically saturated wood and bark, in contrast with the 'hards', which consist of a far more highly disintegrated mass of the most resistant plant residues, forming a minute micro-conglomerate. Chemical examination indicates that the substance of the bright coal was originally of relatively constant composition. The duller component is extremely variable both in visible constitution and in chemical characteristics.

Most seams contain a mixture of the two principal types of material. Their varying proportions, and especially the constitution of the dull coal, give rise to the characteristics of the different seams. The extensive investigations carried out by the Fuel Survey in Great Britain during the past thirty years have shown that individual seams commonly maintain their special features over considerable areas, while all the seams in any field usually show similar changes in 'rank' as they are traced from one part of the field to another. These latter changes are most familiarly indicated by alteration of the percentage of 'volatile' yielded by the coal on heating; this diminishing progressively from the low-rank bituminous coals through the gas-coals, coking-coals and steam-coals to the highest grade anthracites.

Whether the variation of rank in any field be great or small, it follows the same pattern in all seams. Similar changes of rank are found in the vertical sequence of seams at any given point, though this very significant fact is commonly obscured by the individual characteristics of the seams unless a long vertical series can be examined. The rank rises with increasing depth, and accumulating evidence indicates considerable regularity in the rate of change. Our growing knowledge of the causes of the differences among coals leads to the possibility of a more accurate forecast of the probable quality of our remaining resources, and to the conclusion that, while we shall be compelled to work at greater depths, there will be some compensation from the inclusion of a measurably greater proportion of the higher-rank coals.

Dr. C. A. Seyler described his recent investigations into the mode of change of the main constituent (vitrains) of normal coals, as indicated by their increase of reflecting power as the coal advances in rank. Contrary to expectation, this alteration appears to be discontinuous, the reflecting power changing abruptly through a series of nine steps in geometrical progression, and terminating with the highest member, fusinite. In any coal the bulk of the vitrain belongs to one of the lower members, with smaller quantities of the next two or three and usually a little fusinite. As the rank of the seam advances to a critical point, each component present changes its reflecting power (and presumably its composition) one step upward in the series; except, of course, the fusinite.

Exactly similar stepwise changes of the vitrinites are observed in coals which have been subjected to progressive alteration by the thermal metamorphism of sills and dykes. This is shown with exceptional completeness in the case of a Sumatra lignite, which has been changed progressively to an anthracitic condition through a series of stages closely corresponding with normal coals. It seems to afford conclusive proof that heat (and possibly pressure) is capable of accounting for the varying stages of alteration of normal coals.

Dr. A. C. Monkhouse gave an account of the work and results of the Physical and Chemical Survey of Coal Resources during the past twenty-five years by the nine coalfield survey laboratories and the Fuel Research Station at Greenwich. This has given a knowledge of the coal resources of Great Britain more complete than that of any other country in the world. Most of the important seams in all the principal fields have been examined in detail in many places. Analysis band by band has frequently shown how the quality of the coal may be improved by excluding harmful bands, or how particular sections may be put to specially valuable uses. The regional variation of the seams has been traced in detail, and the ground securely laid for a forecast of the changes likely to be encountered as the seams are worked into new areas. Valuable evidence of the variation of coals in the vertical sequence has been obtained by the examination of the series of seams encountered in the exploratory borings for oil.

Following the nationalization of the coal reserves, a rapid survey was undertaken so that a final assessment might be based not only on the quantity but also on a carefully defined estimate of the qualities of the coals likely to be worked in the various royalties during the 'valuation period' (usually a hundred years). The coals were divided into six classes defined by volatile yield and coking properties, and the whole results finally subjected to mechanical analysis so as to reveal the total amounts of each group likely to be worked. This could be compared with the estimated reserves of each type, and led to the

satisfactory conclusion that no type is likely to be exhausted during the next century.

The work of the organisation has naturally been forced to branch in many directions as ever-growing demands have been made upon it. Much work has been devoted to examination and advice related to the open-cast coal developments. Problems concerning the sizing, cleaning and breakage of coal have been investigated. Weathering and storage have been studied, and methods developed for the preservation of coal-dumps with tar cover. The selection and treatment of coals to serve producer-gas units for road-transport vehicles was undertaken during the War, as also the selection of coals to produce active carbon. The loss of the normal sources of sulphur led to an active search for pyritic waste from coal, and the production of 33,000 tons of sulphuric acid from this source. The accumulated knowledge and experience were also utilized for the solution of problems for the Service departments. For the future, the work of this organisation must be of the highest value for the proper planning of coal production and for its most economic and profitable use by the consumer.

As an indication of the need for intensive geological study and practical exploration, Dr. G. H. Mitchell submitted a contribution concerning the problem as it affects the Midland coalfields of Coalbrookdale, the Wyre Forest, South Staffordshire, Warwickshire, South Derbyshire and Leicestershire. These are parts of a natural area of related coalfields containing seams of a limited range of low- and medium-rank coals. The industry and the resultant centres of dense population within the area are founded on these coals, and especially on those of better quality. Within the life-time of the next generation there must be a steady decline in output unless new fields are discovered. Even sooner, the deterioration in average quality as a result of the exhaustion of the better seams will become a serious problem. The matter is therefore urgent.

The geological sequence within each of the fields is fairly completely known. Evidence for the estimation of their mutual relations is available in the marine beds and mussel bands which have been traced from field to field. The actual position, extent and depth of such extensions of these fields as may still lie concealed below the younger rocks of the intervening areas may be doubtfully inferred as the result of intensive geological study. Exhaustive investigation of the evidence of Carboniferous and post-Carboniferous earth-movements, and of the consequent sedimentation and periods of erosion, must form the basis of a forecast. But results can be no more than probabilities and are inadequate for practical development. They can, however, suggest where borings may be located so as to yield the most valuable information. A programme of intensive work, in which boring and geological study proceed hand in hand, is likely to produce practical results at a cost quite infinitesimal in relation to the national importance of the matters involved. Since, however, the complexity of the problems we have now to face in the search for new areas of coal is greater than those hitherto encountered, the boring and exploration programme must needs be far more extensive than any previously undertaken.

Dr. G. M. Lees delivered a communication prepared in conjunction with L. N. Falcon on the relation of the search for oil to the discovery of new coalfields. One considerable buried field has already been proved in central Lincolnshire. Although too deep for present-day exploitation, there is good prospect that it may be at a lesser depth near the Wash. Farther south-eastward, extension of the Nottinghamshire coalfield has also been proved, with the possibility that it may link up with the Wash area. It is a remarkable fact that the Kent coalfield should be the sole example of a buried field hitherto located in Great Britain.

The search for oil has to commence from speculative geological deduction based on the limited surface evidence. Since the rocks and structures concerned are for the most part buried under unconformable cover, the most widespread indications, gathered from the Continent of Europe as well as from Britain, must be brought under review. Selected areas of sufficient promise are then subjected to gravity and magnetic survey to gain a broad generalized picture of the underground structure. From this background the most likely areas are more closely examined by seismic survey, and finally, where indications seem favourable, proved by boring.

The Midlands and south-central England have been generally studied. Of the areas selected within that region, one around Market Drayton and between there and Burton-on-Trent has been subjected to seismic survey. Boring will shortly be commenced. In three other areas, gravity and magnetic survey have been in progress for some twenty months, and results are now being analysed. These are: (1) an area in Wiltshire, where an eastward extension of the Somerset coalfield, or possibly an independent field, may be proved; (2) the Cotswold country in Gloucestershire, and perhaps southern Worcestershire; and (3) certain areas in Oxfordshire, possibly between Oxford and Reading. In addition to these, eastern Essex has been indicated for further study, while numerous other areas exist outside the present programme of investigation where extensions of existing fields or new fields may be found.

Dr. Lees concluded with special emphasis on the need for national effort in this matter. The present programme of private boring can only be subsidiary to the search for oil and at any time may have to be abandoned. Such a possibility is scarcely to be dispassionately contemplated.

The last contribution, from Dr. R. Holroyd, was on coal as a chemical raw material. Chemical industry is largely dependent on the availability of coking-coals; first, for the phenol, cresol, naphthalene and anthracene extracted from the two million tons of coal tar produced annually by coal carbonization, as well as benzene, toluene, xylene, etc.; and secondly, for the production of water-gas or hydrogen for chemical synthesis from about one million tons of coke with high melting-point ash.

The yield of aromatic raw materials is only about 1·5 per cent of the weight of the coal. In the past, this output of by-product by the carbonization industry has sufficed for chemical needs. Now, the anticipated demand greatly exceeds the supply, and investigation has therefore been directed to other sources. Considerable progress has been made in the development of petroleum-cracking plants, and it is probable that the chemical industry in future will be far less dependent on carbonization by-products, though it will continue to provide an outlet for them in so far as they can be produced economically.

The demand for 'synthetic gas' (carbon monoxide and hydrogen or hydrogen alone) is likely to increase considerably. The present high cost has compelled close examination of the efficiency of existing methods

for its production and the investigation of new methods. A provisional scheme for a continuous process based on the 'fluid-solid' technique was described as offering considerable promise. German methods using oxygen may also be developed. While increased efficiency and lower costs must be the primary objective, it is likely that an even more important outcome may be the possibility of using a wider range of coals.

Thus it would appear that the chemical industry in future may be less exacting in its demands regarding types of coal and may obtain a large proportion of its raw materials from other sources. At the same time, it must remain a major consumer of coal as fuel, and its prosperity will depend on ample supplies.

GEORGE HICKLING

BRITISH NON-FERROUS METALS RESEARCH ASSOCIATION

AFTER the annual general meeting of the British Non-Ferrous Metals Research Association on July 10, members and a small number of visitors were shown the laboratory buildings and facilities which the Association now possesses.

In 1930 the first of the Association's laboratories was established by conversion of a small factory near Euston Station, London, and just prior to the War additional laboratories were built on an adjacent site. During the War the original laboratory block was destroyed by enemy action, although the new building was fortunately undamaged. In preparation for post-war expansion, adjacent premises were afterwards purchased; their conversion is now almost completed, and application has been made for a licence to rebuild the war-damaged property. Completion of the present plans will provide a series of laboratories with a total of about 32,000 sq. ft. of floor space in an accessible position in central London. The extension of the laboratories and the corresponding increase in scientific staff, which together will enable a wider range of metallurgical work to be undertaken, have been made possible by the steady and continuing increase in the financial support which the Association receives from industry.

Expansion of the laboratory facilities was particularly required in the Physics, Mechanical Testing and Corrosion Sections, and new accommodation was needed for the recently formed Metal Finishing Section and to house metal-working equipment. Such metal-working equipment will be installed as is needed to prepare experimental alloys in wrought form for test purposes, but it is not intended for fundamental research on the working behaviour of metals and alloys, as it is hoped that such work will be done co-operatively with the British Iron and Steel Research Association in the latter's projected Flow of Metals Research Laboratory.

In accordance with the Association's policy of developing and using modern physical methods for the examination of metals, a Metropolitan-Vickers electron microscope has recently been installed in the physics laboratory and a study is being made of existing replica techniques. Attention will also be paid to the possibility of developing new replica techniques and alternative methods of examining metals in this instrument. Its full potentialities in metallurgical research have not yet been assessed, as its successful use depends so much on the development of satisfactory techniques, but a critical experimental survey is being made of its possible field of use so that members can be suitably advised. The high-tension source of the electron microscope will also be used for electron diffraction work, apparatus for which is being built in the Association's workshops. The Association's pioneering work of many years ago in the application of the spectrograph to the quantitative analysis of non-ferrous metals and alloys is being continued by a systematic study of the use of multiplier photocells in recording spectra and for investigation of excitation conditions.

The expansion of the Mechanical Testing Laboratory is largely to enable more work on creep and fatigue testing to be carried out, including fatigue testing at elevated temperatures, while the extension of the Corrosion Laboratories is called for by the great demands which are made on the Association to-day for further work in the field of corrosion, including stress corrosion.

Simultaneously with the re-planning and extension of its laboratories, the Association has recently reconsidered thoroughly its field of work and the organisation of its activities in relation to the needs of the industry it represents.

The non-ferrous metals industry is a varied group of industries comprising producers, manufacturers and users of the main industrial metals other than iron and steel. It includes a large number of firms with well-equipped and staffed research laboratories, and a number of small firms with little or no research facilities or technical staff of their own. The needs of the members, therefore, vary widely, and the Association's policy is first to carry out long-term researches designed to provide a basic understanding of the factors involved in the fabrication or service life of the materials in question, and secondly to help members, particularly the smaller ones, in the utilization of existing metallurgical knowledge in dealing with their immediate difficulties and in raising the technical efficiency of the industry.

The long-term research programme requires primarily a first-class scientific staff with all the equipment and facilities necessary for their work, but equally important is an adequate knowledge of the technology of the industry. The Association's staff is not by itself in a position to conceive and formulate the long-term projects which should be investigated, and for this purpose several industry research committees have been established consisting of the most highly qualified men of science available in the different sections of the industry. These committees are responsible, in co-operation with the staff, for the formulation of the research programme and for the appointment of sub-committees of industrial technicians, intimately acquainted with each particular problem, for the guidance and advice of the Association's staff in carrying out the work. These committees, of course, do not direct the research work in detail, which responsibility lies with the Director and senior staff, but serve to keep the staff fully informed on the industrial experience which is helpful during the course of the investigation.

At the other extreme, the problems of the small firm, which frequently needs information more than research, are dealt with by the Liaison Department with the backing of a comprehensive Library and Information Service. The Association's liaison staff maintains contact with the industry and with the research work in progress in the Association and elsewhere, and offers confidential service which is

greatly appreciated by the small member in dealing with certain *ad hoc* problems which can be solved in the light of existing knowledge or which require only a small amount of work for their solution. If a problem entails a considerable amount of investigation, this can only be done either by including it in the general research programme or by putting in hand a special research at the cost of the member, the results of which must be made available to all members.

In general, therefore, in the research field the Association's programme of objective fundamental work is intermediate between the purely fundamental work unrelated to specific industrial problems which is proper to the universities, and the more *ad hoc* researches on manufacturing problems which are carried out in the research departments of the larger industrial concerns.

FOURTH INTERNATIONAL CONGRESS FOR MICROBIOLOGY

UNDER the presidency of Dr. Thorvald Madsen the Fourth International Congress for Microbiology was held in Copenhagen during July 20–26. It was attended by more than 1,100 delegates from some thirty-five countries, including a strong representation of more than two hundred persons from the British Isles.

The scientific work of the Congress was divided into nine sections which were concerned with: general microbiology, presidents, Sir Alexander Fleming (Great Britain) and Dr. J. Trefouël (France); medical and veterinary bacteriology, president, Dr. G. Ramon (France); viruses and virus diseases, president, Dr. Carl Kling (Sweden); serology and immunity, president, Prof. Th. Thjøtta (Norway); variation and mutation in micro-organisms, president, Dr. A. F. Blakeslee (United States); plant pathology and mycology, president, Prof. Johanna Westerdijk (Holland); soil and water microbiology, president, Dr. S. A. Waksman (United States); dairy and food microbiology, president, Dr. R. Burri (Switzerland); and industrial microbiology, president, Prof. A. J. Kluyver (Holland). There were, in addition, the four following: general sessions dealing with assimilation of carbon dioxide, Dr. C. H. Werkman (United States); viruses in general, Mr. F. C. Bawden (Great Britain); yeast in modern genetics, Prof. Ø. Winge (Denmark); and antibiotics and life, Dr. S. A. Waksman (United States).

More than three hundred papers were presented at the various sections, interest concentrating principally on the discussions concerning antibiotics—with particular reference to penicillin and streptomycin—diphtheria, pertussis, pathogenic streptococci, tuberculosis, brucellosis, poliomyelitis and influenza, the mechanism of infection and immunity, the physical and chemical investigation of antigens and antibodies, bacteriophage, induced mutation, virus diseases of plants and phytopathogenic fungi, soil ecology, micropopulation and nitrogen fixation, food poisoning, bacteriology of dairy products, brewing and fodder yeast production.

In connexion with antibiotics, Dr. P. M. D'Arcy Hart described the bacteriostatic action of licheniformin, derived from a strain of *Bacillus licheniformis*, against a number of Gram-positive bacteria including *M. tuberculosis*, and directed attention to the fertile field for exploration among the aerobic spore-formers. The classification of this group has now been reduced from its former chaotic state by the taxonomic studies of Nathan R. Smith, Ruth E. Gordon and F. E. Clark in the United States and of T. Gibson in Great Britain, which have placed nomenclature on a sure foundation. Dr. C. H. Andrewes and Dr. Forrest Fulton reported the setting up of a unit for the study of common colds in the buildings of the Haward Hospital, Salisbury, which has been planned for a long-term research project. Attempts are being made to cultivate the exciting factor, which is tentatively presumed to be a virus, or to reproduce the disease in some convenient animal. The development of these researches will be awaited with much interest.

Dr. A. Felix contributed a paper on the nature of bacteriophage. Although the view is held by most bacteriologists that bacteriophages are bacterial viruses, he thought that the facts could be explained with less strain on the imagination if we assume that bacteriophages are not separate biological entities and that their nature is determined by the specific antigenic substances from which they are derived. In the same section (III) Dr. W. I. B. Beveridge directed attention to the similarity of the viruses of mumps and influenza with regard to their hæmagglutination activity, growth in chick embryo and size of virus particles; while in Section IV Dr. F. Kauffmann described a diagnostic schema for the *coli* group based on antigenic features. He expressed the view that the taxonomy of the Enterobacteriaceæ should start with type-diagnosis based on serological features and that the old classification within the *coli* group, based on fermentation reactions, differentiating *B. coli commune*, *B. coli communior*, *B. acidi lactici*, etc., was obsolete.

With so much material for notice and for comment it is difficult to make selection of a few salient papers, but those on phage typing of *Shigella sonnei* (E. Hammarström), "Les Hyphomycètes prédateurs des larves de Nématodes parasites des plants et des mammifères" (R. Deschiens and L. Lamy), Dr. C. E. ZoBell's paper with reference to the depth at which bacteria are active in marine bottom deposits and the series of papers dealing with the production of fodder yeast are perhaps deserving of especial mention, which applies also to the technical excellence of Dr. R. W. G. Wyckoff's photographs illustrating his paper on electron microscopic study of the antigen-antibody reaction and to Dr. J. Comandon and Dr. P. de Fonbrune's film illustrating "Champignons prédateurs de Nématodes du sol".

While plant pathology and mycology were well catered for, one would have wished to see a sub-section of the Congress devoted to medical and veterinary mycology, a subject of growing importance and to which notable contributions have recently been made by the employment of new techniques and methods of research; in this connexion the names of N. F. Conant and C. W. Emmons in the United States and of J. T. Duncan in Great Britain come readily to mind. One may hope that at the next International Congress for Microbiology this important branch of mycology, and also the field of protozoology, will receive due recognition.

Apart from the general programme of the scientific work of the Congress a number of committees carried out duties of considerable importance. The Permanent International Commission for the Organisation of Congresses drafted new statutes for the International Association of Microbiologists (I.A.M.B.) which had become necessary on account of the relationship that the Association bears to the International Union of Biological Sciences (I.U.B.S.), of which it is now a

microbiological section and is thus in organic association with the International Council of Scientific Unions (I.C.S.U.) and with the Division of Natural Sciences of the United Nations Educational, Scientific and Cultural Organisation (U.N.E.S.C.O.). Meetings of the Permanent International Committee on Bacteriological Nomenclature and of the Judicial Commission on Bacteriological Nomenclature were also held at which the "Proposed Bacteriological Code of Nomenclature," edited by R. E. Buchanan and R. St. John-Brooks was presented for approval and for subsequent publication in the *Proceedings* of the Congress.

Action was also taken by the Nomenclature Committee and the Permanent Commission in welcoming the proposal that the Centre de Collection de Type Microbiens, Lausanne, Switzerland, under the direction of Prof. Paul Hauduroy, should be associated with the International Association of Microbiologists, both with regard to the preparation of a "World Catalogue of Strains of Micro-organisms" and also in the formation of an International Federation of Culture Collections of Micro-organisms. These matters had already received the support and approval of U.N.E.S.C.O., and a small *ad hoc* Commission of the Nomenclature Committee of the Association was formed under the chairmanship of Prof. A. J. Kluyver for overall advice and the administration of any grants-in-aid that might in future be allocated.

A meeting of the *Salmonella* Sub-committee also took place under the chairmanship of Dr. F. Kauffmann. A new and revised report of the work of the *Salmonella* Sub-committee was presented for publication in the Congress *Proceedings*, and the sub-committee was reconstituted under the name of the "Enterobacteriaceæ Sub-committee" so as to include the consideration of problems dealing with *Shigella* and the *coli* group. New sub-committees of the Nomenclature Committee were also constituted dealing with the immediate study of the taxonomy and nomenclature of *Streptococcus*, *Clostridium* and *Mycobacterium*, and for the general outline classification of Schizomycetes to be considered at the next Congress. A meeting of a committee for Phage Typing, to which representatives from fourteen countries had been invited, was held under the chairmanship of Dr. A. Felix.

It was, perhaps, inevitable that the subject of biological warfare should obtrude itself at a congress of this nature, and the matter being raised at the meeting of the International Commission the following resolution was drafted for presentation at the plenary session of the Congress, where it was afterwards passed by acclamation:

"The Fourth International Congress for Microbiology joins the International Society of Cellbiology in condemning in the strongest possible terms all forms of biological warfare. The Congress considers such barbaric methods as absolutely unworthy of any civilized community and trusts that all Microbiologists throughout the world will do everything in their power to prevent their exploitation."

An invitation from the Brazilian Government to hold the Fifth International Congress for Microbiology in Rio de Janeiro in the latter part of 1950 was presented at the meeting of the Permanent Commission by the chief of the Brazilian delegation to the Congress—Dr. H. C. de Souza Araujo. This invitation was accepted by the members present with applause and was afterwards ratified at the plenary meeting of the Congress.

Apart from the exchange of scientific knowledge and the exploration of the ever-widening horizons of research, one of the most important functions of international congresses of this kind is the formation of fresh personal contacts and the renewal of old associations and friendships. This was peculiarly applicable to the present occasion when, owing to the brutal intervention of global war, nearly eight years had passed since a similar concourse had gathered in New York City under the shadow of a world catastrophe. The social side of the Congress's activities, which included much public and private entertainment, was an unqualified success, and it speaks much for the Danish Organising Committee, its general secretary, Dr. M. Björneboe, and the many friends of the Congress that their efforts were so completely vindicated. At the end of the week the delegates returned to their scattered homes with happy recollections of good fellowship, of high endeavour and of successful achievement.

RALPH ST. JOHN-BROOKS

OBITUARIES

Dr. H. T. Calvert, M.B.E.

WITH the death from heart failure of Harry Thornton Calvert in his seventieth year on September 23, there has passed away a leading authority on the science and technology of water supplies, sanitation, and the prevention of pollution of rivers and underground water resources. He was born in Leeds, Yorkshire, on May 3, 1878. Following his early education he proceeded to the Yorkshire College (now the University of Leeds), to study in the honours school of chemistry. Calvert was soon recognized as a student of more than average ability. On graduation in 1898, he was at once awarded an 1851 Exhibition and went to Leipzig, where he remained until 1901 and took the Ph.D. degree.

On return from Germany, Calvert served for a short time as a demonstrator under the late Prof. Arthur Smithells at the University of Leeds, before taking up an appointment as chemist to Messrs. Reckitt and Sons, of Hull, with which firm he gained valuable experience in chemistry applied to industrial problems. In 1903, he moved to become chemist to the West Riding of Yorkshire Rivers Board, a joint committee of local authorities which had been set up to administer the Rivers Pollution Prevention Acts. This change in his scientific activities marked the beginning of his interest in the problems of water supply and sanitation generally, a subject which remained his chief interest throughout the rest of his career.

At that time Dr. Maclean Wilson was chief inspector of the Rivers Board. Calvert and he were ideal partners in guiding this important work. They were not inspectors in the narrow sense of the word; but studied in detail the problems of treatment and disposal of sewage and the manufacturing processes in the West Riding which gave rise to the discharge of polluted waste waters. As a result they fully recognized the difficulties to be overcome, and devoted their energies largely to guiding and assisting managers of sewage disposal works and manufacturers in solving their problems. In consequence, the work of the Rivers Board reached a high standard and set an example to the rest of the world. Wilson and Calvert collaborated in writing the book "Trade

Waste Waters: Their Nature and Disposal", which has long been the authoritative work on this subject. It was while he was with the Rivers Board that Calvert was awarded in 1915 the D.Sc. degree of Leeds.

In 1920 Calvert moved to London to take up a new appointment as chemical inspector of the Ministry of Health, a post which gave him wide scope and in which he was eminently successful. When in 1927 the Department of Scientific and Industrial Research set up a water pollution research organisation, Calvert was the obvious choice as director of research, and he undertook this responsibility in addition to continuing his work for the Ministry of Health. He did not believe in rapidly developed schemes of a grandiose character, but in steadily building up on a sure foundation. This policy he followed in guiding the work of the Water Pollution Research Board in excellent partnership with every member of the Board, which was under the chairmanship of Sir Robert Robertson. By 1939, the research organisation had several outstanding achievements to its credit, including a comprehensive survey of the River Tees, an investigation into the effects of discharges of sewage into the River Mersey in relation to problems of navigation, improvements in methods of treatment of sewage, and the development of practicable methods of dealing with the problems of reducing pollution by such trade waste waters as those from beet sugar factories, milk depots, cheese and butter factories, to mention only a few items.

Calvert was recognized as an authority in his field not only in Great Britain, but also throughout the world; and he had close friendship with many professional colleagues on the Continent and in the United States. In addition to his many papers and addresses in Great Britain, including a Chadwick Public Lecture in 1926, he accepted an invitation in 1939 to give the Sedgwick Lecture in the following year at the Massachusetts Institute of Technology, but unfortunately was prevented by the outbreak of war from delivering the lecture. In 1944 he received the Kenneth Allen Award of the American Federation of Sewage Works Associations.

He took a keen interest in the work of the Institute of Sewage Purification, of which he was president in 1927, 1928 and 1939, and was a member of the Council of the Institute for many years. Calvert was also a prominent fellow of the Royal Sanitary Institute, and the Institution of Sanitary Engineers, a professional associate of the Institution of Water Engineers, a member of the Society of Chemical Industry, and a fellow of the Royal Institute of Chemistry and of the Chemical Society.

During the First World War, from 1916 until 1919, he was with the Department of Explosives Supply of the Ministry of Munitions, and his work was recognized by the award of the M.B.E. On the outbreak of war in 1939 he was seconded to the Ministry of Supply as deputy controller of sulphuric acid, which post he retained until his retirement early in 1947.

Calvert was a man of kind heart and generous disposition, with a marked ability in quietly getting boards, committees and staff working together amicably and efficiently, and all who worked with him came to know him as a close friend. He was devoted to his family. The death of his wife in 1937 was a severe blow to him. All three of his sons have had distinguished university careers, one in physics, a second in chemistry and engineering, and a third in arts and law.

A. PARKER

Surgeon Rear-Admiral C. M. Beadnell, C.B.

SURGEON REAR-ADMIRAL CHARLES MARSH BEADNELL, who died at Petersfield, Hampshire, on September 27, was president of the Rationalist Press Association, Ltd., and the author of several scientific books. Born at Rawalpindi in 1872, he was educated at Cheltenham College; and after studying medicine at Guy's Hospital he joined the Navy as a surgeon in 1896. He came to intellectual maturity while the great evolution controversy was still raging, and fell under the spell of Huxley. He became an ardent rationalist, and although service conditions somewhat restricted the propagation of his views, he frequently contrived to give lectures on evolution to the 'lower deck'. On one occasion the commander-in-chief attended, and instead of administering the expected rebuke, he merely remarked that he had enjoyed the lecture very much; but, he added: "On second thoughts, Adam and Eve are good enough for me".

Beadnell's enthusiasm for science led him to buy, out of his own earnings, an X-ray apparatus, the first to be used in the Royal Navy. In the American-Filipino War he collected specimens of bullet injuries to skulls, when he found that the Filipinos did not bury their dead. During the Boer War, when pronounced medically unfit for front-line service he broke away from a hospital train and tramped all night to take part in the fighting at Graspan. The *Titanic* disaster stimulated him to invent an air-distensible waistcoat.

In 1922 Beadnell represented the Navy and Army Medical Departments at the International Congress of Surgeons at Washington. On his return he became head of Chatham Hospital, retiring at his own request four years later. Retirement brought him the opportunity to devote much of his time, and his gift for simple exposition, to general science and the cause of rationalism. The fire kindled in the great days of Huxley never died; but perhaps the strongest influence was that of W. K. Clifford. His intellectual integrity was as unquestionable as his physical courage, but he was no fanatic. In a revealing letter, written the day before he died, he declared that Clifford had brought him from "the respectable sphere of Agnosticism to that of Atheism; not of the blatant type, but of a convinced, quiet kind in which I would not argue in public on religious questions, if other officers I knew to be religiously persuaded happened to be present". He became a director of the Rationalist Press Association and succeeded Lord Snell as president in 1940. Among his publications were: "Evolution of Speech", "Picture Book of Evolution (after Dennis Hird)", "Origin of the Kiss", "Dictionary of Scientific Terms" and "An Encyclopædic Dictionary of Science and War".

Prof. Paul Guthnick

PROF. PAUL GUTHNICK was born at Hitdorf am Rhein on January 12, 1879. After studying under Küstner at Bonn, he became an assistant at the Berlin Observatory in 1901. After three years at the Bothkamp Observatory, he returned to Berlin in 1906 and moved steadily up in the scale of Observatory and University posts until 1921, when he succeeded Hermann Struve as professor of astronomy in the University of Berlin and director of the University Observatory at Berlin-Babelsberg. In 1927 he was elected an associate of the Royal Astronomical Society.

Guthnick's chief work lay in stellar photometry, and he was particularly successful in developing photo-electric methods, carrying out many pioneer investigations. He worked largely with stars of very small and irregular variations, but he also studied Mars and the satellites of Jupiter and Saturn. He applied photo-electric methods to measure the colour indices of stars, notably Nova Aquilæ 1918. His original and somewhat unorthodox outlook was reflected in theories that he put forward for several classes of variable stars.

He died in hospital in Berlin on September 6.

We regret to announce the following deaths:

Prof. A. T. Cameron, professor of biochemistry in the University of Manitoba, author of well-known text-books on biochemical studies, on September 25, aged sixty-five.

Prof. J. Masson Gulland, F.R.S., Sir Jesse Boot professor of chemistry in University College, Nottingham, on October 26, aged forty-nine.

Prof. F. E. Lloyd, emeritus professor of botany in McGill University, Montreal, aged seventy-nine.

NEWS and VIEWS

Nobel Prize for Physiology and Medicine, 1947: Prof. Bernardo A. Houssay, For.Mem.R.S.

One part of the Nobel Prize for Physiology and Medicine for 1947 has been awarded to Prof. Bernardo A. Houssay, recently professor of physiology in the University of Buenos Aires (see *Nature*, November 23, 1946, p. 739). Before Houssay took up his investigations on the influence of the pituitary gland on carbohydrate metabolism, it was confidently believed that the posterior part of the gland was thus concerned. More than twenty years ago, Houssay and his collaborators showed without question that the anterior portion of the gland is of importance in this connexion, and their demonstration that the dog from which both the pituitary gland and the pancreas were removed survived much longer than the animal from which the pancreas alone was removed was of outstanding importance in demonstrating that carbohydrate oxidation can occur in the complete absence of insulin. It thus became clear that insulin enhanced glucose utilization in the body, while anterior pituitary secretions inhibited it; and in keeping with this, Houssay and others were later able to show that extracts of the anterior lobe exert a diabetogenic action in the normal dog.

Prof. Carl F. Cori and Mrs. Cori

The other part of the Nobel Prize has gone to Prof. Carl F. Cori and Dr. Gerty T. Cori, of the Washington University School of Medicine. Prof. and Mrs. Cori have pursued a line of investigation which has now to some extent merged with that of Houssay and his colleagues. The Coris have investigated for the past twenty years or so the changes undergone by the glucose molecule, and the enzymes responsible for the changes, in the processes of glycogen formation and breakdown in the animal body. In 1939 they were able to prepare for the first time an enzyme which catalysed the synthesis *in vitro* of a polysaccharide resembling starch and glycogen. More recently they have examined the action of the enzyme hexokinase, responsible for the phosphorylation in the body of glucose to glucose-6-phosphate at the expense of the conversion of adenosine triphosphate to adenosine diphosphate. The Coris have been able to show that anterior pituitary extract and insulin exert antagonistic actions on this enzyme system *in vitro*, anterior pituitary extracts depressing hexokinase activity, and insulin neutralizing this depression. This observation goes a long way to explain in terms of enzyme systems the action of some of the hormones the physiological investigation of which has been the pursuit of Houssay and his collaborators.

Physiology at St. Bartholomew's Hospital Medical College: Prof. K. J. Franklin

By the appointment of Dr. K. J. Franklin, acting director of the Nuffield Institute for Medical Research, Oxford, to the professorship of physiology in the University of London tenable at St. Bartholomew's Hospital Medical College, Oxford loses a scholar who has served the University for many years, and 'Bart's' reclaims a former student. After serving in the R.F.A. in the First World War, Franklin went as a classical scholar to Hertford College, Oxford. He turned to biology and medicine, gaining the Welsh Memorial Prize for anatomical drawing in 1920, and first-class honours in animal physiology the following year. After a period as lecturer in Oxford and in London, he returned to Oxford in 1924 as fellow of Oriel and demonstrator in the Department of Pharmacology, but a year later was off again as a Radcliffe Travelling Fellow, which appointment he combined with an assistant professorship of physiology in the University of Michigan. He shared the Radcliffe Prize for research in 1933, and was dean of the Oxford Medical School from 1934 until 1938, and acting dean during the Second World War.

Apart from teaching, of which Franklin has done a great deal in Oxford (his pupils number more than a hundred), he divided most of his time between the experimental study of the circulation in general and veins in particular, and the history of medicine with particular reference to the circulation. In the latter studies Franklin's early classical training served him in good stead. When the Nuffield Institute of Medical Research was established in 1935, Franklin accompanied Prof. J. A. Gunn from the Department of Pharmacology as the Institute's assistant director. Here he turned his attention to the study of the circulation by cine-radiography, a technique which he studied under Janker in Bonn. In this work he collaborated with Dr. A. E. Barclay and the late Sir Joseph Barcroft; their studies of the fœtal circulation have already been published. More recently Dr. Trueta joined the team, and their study of the renal circulation has just been published by Basil Blackwell of Oxford. This work has provided a very useful technique that will no doubt be applied to other organs, and has also given important physiological information regarding the mechanism of the circulation. Since Prof. Gunn's retirement, Franklin has been acting director of the Institute. No doubt Franklin will continue similar studies in London when he is able to gather together the elaborate equipment needed. In the interval of doing this, we look forward to a continuation of his publications on the history of physiology.

Botany at McGill University: Prof. Nicholas Polunin

THE recent appointment of Dr. Nicholas Polunin to the Macdonald professorship of botany in McGill University, Montreal, was an especially suitable one in that arctic botany has long been one of Dr. Polunin's chief interests and he has devoted special attention to the flora and ecology of north-eastern Canada. Since 1930 he has made several expeditions inside the Arctic Circle, ranging from Lapland and Spitsbergen in the east through Greenland to the territories covered by the Canadian Eastern Arctic Patrol. The Canadian Department of Mines and Resources has sponsored his work on "The Botany of the Canadian Eastern Arctic" to be published in four parts, three of which have already appeared.

Dr. Polunin went to Christ Church, Oxford, with an open scholarship in natural science in 1927. He graduated in the Final Honours School of Natural Science in 1932 and was awarded a Goldsmith's Senior Studentship. Later he received the degrees of D.Phil. and D.Sc. In 1933 he was awarded a Henry Research Fellowship at Yale University, of which he holds the degree of M.S. (1934). Returning to Oxford he was elected to a senior research scholarship at New College, during the tenure of which he was also research associate at Harvard (1936–37). Since 1938 he has been curator of the Fielding Herbarium, Department of Botany, Oxford, and in 1939 was elected University demonstrator. In 1946 he was elected to a research fellowship at New College. With the cessation of hostilities, fieldwork again became possible, and in 1946 Polunin was granted leave of absence from Oxford in order to allow him to accept a visiting professorship at McGill and take part in further expeditions to the north-east of Canada, which he has done during the summers of 1946 and 1947.

Brigadier D. P. J. Kelly

BRIGADIER D. P. J. KELLY has recently retired from the post of controller of the Royal Army Educational Corps. Born in London in 1887 and educated at the University of Cambridge, he was commissioned into the Connaught Rangers in 1915 and was gazetted as a captain in the Army Educational Corps in 1920. Following eleven years of service in India, he returned home in 1940 and was appointed command education officer in Scottish Command. In this post he was responsible for the introduction of the war-time scheme of education, and the friendly relations which continue to exist between the Army and the Scottish universities, the Scottish Education Department and the voluntary bodies engaged in educational work in Scotland, owe much to his ability and personality. Selected as controller in 1944, at a time when the educational scheme for the release period was being planned, he worked in the closest co-operation with Sir Philip Morris. More recently, he has been actively engaged under Major-General Cyril Lloyd in planning the future organisation of the Royal Army Educational Corps.

Scientific Development in China

THE members of the Chinese Association for the Advancement of Science, the Natural Science Society of China, the Chinese Astronomical Society, the Chinese Meteorological Society, the Chinese Geographical Society, the Chinese Zoological Society and the Chinese Anatomical Society, gathered at their joint annual conference in Shanghai during August 30–September 1, passed resolutions, the substance of which is printed below, on the control of atomic energy and on the development of scientific research in China.

(1) Atomic research. Chinese scientific workers feel that the probing into the mysteries of atomic energy, like scientific research work in all other fields, should have as its objective the promotion of human welfare. The energy of the atomic nucleus was successfully released at a time when the democracies were locked in a life-and-death struggle with the totalitarian States; and quite naturally it was taken advantage of in the making of weapons of war. This is unfortunate for atomic energy and also for scientific research. Now that the War has been concluded and the democracies are endeavouring to bring about world co-operation, atomic research should be freed from its close-guarded secrecy, to be directed towards the advancement of the application of other achievements in atomic research.

(2) Scientific research in China. The Chinese as a race are still facing starvation and other acute shortages in this atomic age, backwardness in the development of science being one of the causes. The significance of such development is in its power to raise proportionately the standard of living. Sufficient emphasis has not hitherto been given to the fundamental sciences; and a mature status in scientific work will not be acquired suddenly by the importation of a few instruments for atomic studies. Foundations must be laid first by the strengthening of the physical equipment for science education and by extending adequate facilities and stable living conditions to teaching and research personnel in China. What is more important, China should adopt a definite and long-range plan for the development of scientific undertakings, with the necessary budgets to carry it out to the fullest extent. If science is to serve as an important contributing factor in the reconstruction of China, it must be made to stand on firmer ground; scientific development cannot be bought ready-made.

Chinese Association for the Advancement of Science

THE Chinese Association for the Advancement of Science (formerly the Science Society of China) held its twenty-fifth annual meeting during August 30–September 1 at the Academia Sinica and National Medical College of Shanghai, Shanghai, with the Natural Science, Astronomical, Meteorological, Geographical, Zoological and Anatomical Societies of China. Mr. H. C. Zen presided over the meeting; Dr. W. H. Wong discussed secrecy in scientific research and its effects, and Dr. K. C. Chu emphasized the utilization of scientific knowledge for peace. Besides the presentation of papers in different sections, there were discourses on "Atomic Energy and Peace", "Improvement of Scientific Education in China", and other public lectures.

Home and Factory Power Exhibition

A SMALL exhibition entitled "Home and Factory Power" was opened in the main hall of the Science Museum by Lord Citrine, chairman of the British Electricity Authority, on October 21. The exhibition will remain open until the end of January and is intended to show visitors that it is their personal responsibility to avoid the overloading of power stations and gas plants during the peak hours. In

his opening remarks, Lord Citrine anticipated a five-year shortage of electrical plant in spite of the fact that the manufacturers are attempting to double their 1938 output. Consequently, with electric power demands already 60 per cent above the 1938 level, and the effects of the war-time lag in extensions and maintenance still to be caught up, there are bound to be power cuts in this and succeeding winters unless the domestic consumer is much more careful. In the exhibition this point is brought home by a series of working models. Thus, by pressing a button the visitor brings on an electric fire but at the same time stops the operation of a model workshop. The workers sit down to wait until the fire is switched off again. An illuminated label at the same time stresses the need to avoid the peak load hours of 8–10 a.m. and 4–6 p.m. The loads taken by various domestic gas and electric appliances are shown by a colourful series of panels, which also suggest how to make reasonable savings without undue austerity.

American Institute of Physics

Mr. Cleveland Norcross, formerly executive secretary of the Office of Scientific Research and Development, the official organisation which co-ordinated American scientific work during the War, has been appointed to the newly created post of assistant director of the American Institute of Physics; Dr. H. A. Barton continues as director of the Institute. The administrative change has been necessitated by the enormous increase in the administrative burdens of the Institute, largely due to the continued increase in the number of physicists (the number has trebled in the past ten years, but which is by no means sufficient yet to meet the demands of industry, government research and teaching establishments), and to the growing recognition by the general public of the part that physics does and should play in industrial and national progress. The director will continue to be responsible to the governing board for the general supervision of the Institute, but will be primarily responsible for matters of policy and relations between physical organisations and allied bodies. Advertisement, appointments, public relations, and attention to matters affecting the member societies of the Institute will be the main concern of the assistant director.

International Scientific Film Association

At a congress in Paris during October 2–9, arranged jointly by the Institut de Cinématographie Scientifique and the Scientific Film Association, it was decided to form an International Scientific Film Association. A provisional constitution was agreed by the delegates from twenty-two countries, under which the Association will have a main meeting each year, but between these main meetings the affairs of the Association will be managed by a council comprising five officers and seven other members. The Council for the present year is: *President*, M. Korngold (Poland); *Vice-Presidents*. J. Maddison (Great Britain) and Prof. Pinto (Brazil); *Hon. Secretary*, M. Jean Painlévé (France); *Hon. Treasurer*, M. Sallaz (Switzerland); and one delegate each from Australia, Austria, Belgium, Canada, Czechoslovakia, Malaya and Mexico. The Association will be concerned with all aspects of scientific film matters. The exchange of information through the office of the Association (which will be established in Paris at an early date) will begin at once on scientific and technical films that are already available for exchange, on methods of appraisal, and on customs regulations on the exchange of films. Concurrently with each annual meeting of the Association, which will be held in different countries by invitation, there will be an examination of new scientific and technical films. The 1948 Congress is to be held in Great Britain in October; arrangements are being put in hand by the Scientific Film Association of Great Britain, 34 Soho Square, London, W.1.

Archæological Work in Greece

During the war years little archæological excavation was possible in Greece; but here and there minor discoveries were made, and these are summarized in the annual report of the Committee of the British School of Archæology at Athens. It appears in the *Journal of Hellenic Studies*, **64** (1944), and carries the story down to 1945. There are some illustrations, including a portion of a tholos tomb discovered near Knossos.

University of London: Appointments

The following appointments in the University of London have been announced: Prof. Henry Barcroft, since 1935 Dunville professor of physiology in the Queen's University of Belfast, to the University chair of physiology tenable at St. Thomas's Hospital Medical School as from January 1, 1948; Dr. T. D. Day, to the University readership in pathology tenable at St. Thomas's Hospital Medical School; Dr. Russell Fraser, to the University readership in medicine tenable at the British Postgraduate Medical School; Dr. C. J. O. R. Morris, to the University readership in chemical pathology tenable at the London Hospital Medical College.

The title of professor emeritus of mining geology in the University has been conferred on Prof. W. R. Jones on his retirement from the chair of mining geology at the Imperial College of Science and Technology.

The degree of D.Sc. has been conferred on the following: Mr. Sachindranath Dasgupta (Imperial College of Science and Technology); Mr. Norman Davy; Mr. R. L. Knight (Wye College); Mr. W. S. Martin (Imperial College of Science and Technology); Prof. Claude Rimington (University professor of chemical pathology, University College Hospital Medical School); Mr. Yung Chow Wong (King's College).

Announcements

A joint conference of the Midland Branch and the X-ray Analysis Group of the Institute of Physics to discuss "The Structure and Physical Properties of Metals" will be held at Birmingham during November 20–21. Further particulars of the meeting, which is open free of charge to all who are interested, can be obtained from J. N. Kellar, honorary secretary of the X-ray Analysis Group, Crystallographic Laboratory, Cavendish Laboratory, Cambridge.

The annual conference of the Agricultural Section of the Association of Scientific Workers will be held during November 8 and 9 at Gas Industry House, Hyde Park Corner, London. Sir John Fryer, secretary of the Agricultural Research Council, will address the first session at 3 p.m., which is open to all agricultural scientific workers.

Dr. William A. Hamor, of the Mellon Institute, Pittsburgh, has been appointed editor of the Chemical Monographs of the American Chemical Society. This series of reference volumes now numbers 105.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

A New Adsorption Apparatus and the Separation of Aspartic and Glutamic Acid

THE need has been felt in this laboratory for a simple apparatus capable of recording eluate concentrations by chemical means. The main features of an apparatus made for this purpose are: a syringe to force the solution through the adsorption column, from which a flexible canula and a capillary-drop tip convey the eluate to a rotating metal drum, on which a filter paper is fastened. The drop tip is pushed along the lowest generatrice of the cylinder and at regular intervals lifted up to the paper, where a drop of the eluate is deposited. The device for this lifting (not shown in Fig. 1) is operated from a cog-wheel on the left end of the drum. Syringe, drum and drop tip are driven synchronously by an electric motor through a system of cog-wheels and threadworms.

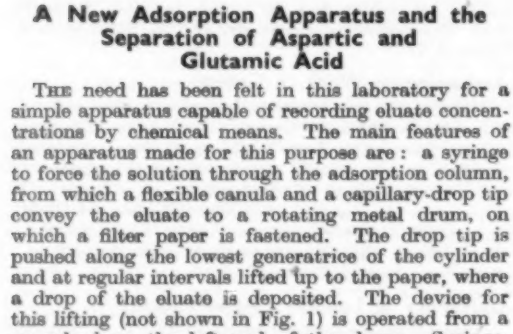


Fig. 1. SCHEMATIC DRAWING

The paper can be either used directly, when dyes are analysed; or prepared in advance with some reagent which, during the run or after some special treatment, gives a colour with the eluted substances; or afterwards sprayed with a suitable reagent solution. After development, if this is needed, the colour intensities of the spots are compared subjectively with each other and with spots obtained from solutions of known concentration.

The model apparatus is built in a compact manner on a metal plate, 140 mm. × 310 mm. The drum is 120 mm. long and 75 mm. in diameter. Twenty spots are obtained for each revolution of the drum, to which corresponds a 10 mm. displacement of the drop tip. About ten revolutions can be run, which means a total of about 200 spots, that is, with a 20 ml. syringe one obtains one analysis for each 0·1 ml. As the quantity deposited on the paper is about 3 μl., it is seen that the major part of the eluate will flow down from the drop tip, and if the liquid is collected here, a correction can be made for the substance lost in the spots. As the next step I intend to construct a synchronous eluate collector, which can change the eluate tubes for, say, each fourth spot. (A similar apparatus has been described by Moore and Stein[1].)

The apparatus is simple and relatively inexpensive, it is very convenient and omits much work with continuous interferometer readings or excessive eluate fractionating and analysing[2,3]; but one must know some good spot test reaction for the substances investigated. A great advantage over physicochemical methods is that this apparatus works independently of the solvent, which can be changed during the run without affecting the spot reactions. Likewise, other substances can be present without harm, provided they do not give a colour reaction. Sometimes the chemical method will make it possible to observe simultaneously the individual concentrations of two or more substances.

In order to test the apparatus, I studied the behaviour of the two dicarboxylic amino-acids on a column of the ion exchange resin 'Amberlite IR—4'. It was found that, after adsorption from an aqueous solution, both of them were eluted with *N* hydrochloric acid at a high rate, obviously by being displaced by the strong acid front. With smaller concentrations the aspartic acid was overtaken by the hydrochloric acid front, while the glutamic acid was still more or less displaced. The best results were obtained with about *N*/100 hydrochloric acid, but even here the separation was not complete. Better results were obtained with acetic acid, which in a concentration of 0·05 per cent gave a fairly good separation. Two control runs were made to test the separation:

(1) About 3 mgm. each of the two amino-acids were adsorbed in a glass filter on 630 mm.³ of 'Amberlite IR—4B', pretreated with *N* hydrochloric acid and water[4]. The elution was performed from a 10 ml. syringe, which gives 1·4 ml. for each revolution of the drum, that is, one spot for each 0·07 ml. First, 11 ml. of 0·05 per cent acetic acid were forced through to elute the glutamic acid, and afterwards, with a new paper on the drum, 4 ml. *N* hydrochloric acid to elute the aspartic acid, which comes out too slowly when the dilute acetic acid is used. After the two runs, which lasted for 70 min. and 30 min. respectively with a 10 min. interval between, the papers were sprayed with a ninhydrin solution and heated. During the runs, eluates corresponding to each revolution of the drum had been fractionately collected, and after the development they were poured together in four fractions (see Fig. 2). These were analysed by the micro-Kjeldahl procedure, which gave the following results. (The somewhat high value for aspartic acid nitrogen in this preliminary analysis can be due to a contribution from the resin, when this is eluted with *N* hydrochloric acid[4].)

RESULTS OF THE MICRO-KJELDAHL DETERMINATION

Fraction	I	II	III	IV
μ gm. nitrogen found	10	302	4	319
Corrected for substance in the spots	10	315	4	332
μ gm. nitrogen calculated	(0)	325	(0)	311

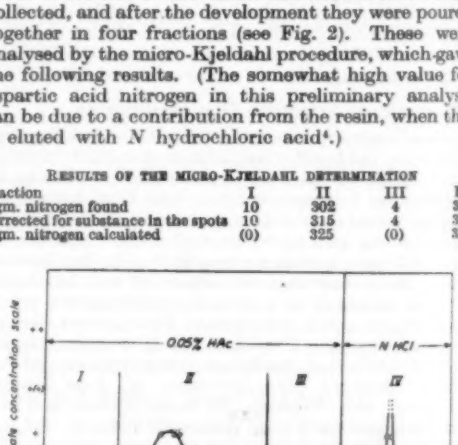


Fig. 2

(2) In another experiment the eluate was divided into two fractions, which were examined by one-dimensional paper chromatography with phenol–0·1 per cent ammonia–coal gas[5]. Also in this manner the effectiveness of the separation was entirely confirmed.

While several methods have been described, using the column procedure with inorganic adsorbents or the batch procedure with 'Amberlite IR-4' for the separation of the two dicarboxylic amino-acids, this method is the first to use an ion exchange resin in flowing chromatography for this purpose.

Note added in proof. While this letter was in the press, I was told that Consden *et al.* are about to publish a similar method.

BIRGER DRAKE

Institute of Biochemistry,
Uppsala.
June 26.

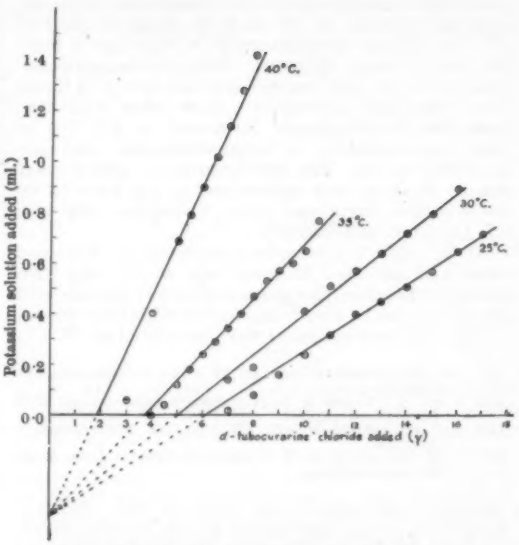
[1] Stein and Moore, lecture at the American Chemical Society Congress, April 1942 (not yet published).
[2] Claesson (Diss.), *Arkiv f. Kemi, Min. och Geol.*, **23 A**, No. 1 (1946).
[3] Strain, "Chromatographic Adsorption Analysis" (New York, 1942).
[4] Tiselius, Drake and Hagdahl, *Experientia*, **3**, 651 (1947).
[5] Consden, Gordon and Martin, *Biochem. J.*, **38**, 224 (1944).
[6] For references, see, for example, Cannan, *Ann. New York Acad. Sci.*, **47**, Art. 2, 150 (1946).

Antagonism Between Curare and the Potassium Ion

It has been known for some time that a fall of temperature can reverse the motor end-plate blocking action of curare[1]. There seems to be two possible explanations of this strange phenomenon. The simplest hypothesis is to regard the reaction between curare and the receptor as a reversible dissociation which increases with decreasing temperature, a most unusual assumption. Alternatively, we might assume that the curare was being antagonized by some naturally occurring substance (cf. Ing and Wright[2] in this connexion), and that as the temperature was lowered the competition went against the curare. Since Wilson and Wright[3] have shown that potassium antagonizes curare, we investigated this competition quantitatively in order to determine the influence of temperature on the antagonism between added curare and the naturally occurring potassium ions.

Enough curare (*d*-tubocurarine chloride) was added to a slip of rat diaphragm to paralyse to a steady value of 50 per cent. More curare and Tyrode containing 100 times the normal amount of potassium chloride were then very carefully added in such a way as to keep the block steady at 50 per cent. In this way, it was found possible to back-titrate curare with the K^+ ion. The results (see graph) show that at constant temperature curare and potassium are in direct linear antagonism, and that within the limits of experimental error the graphs on extrapolation pass through the vertical axis at a point corresponding to zero potassium concentration in the fluid surrounding the muscle. The point at which each line crosses the horizontal axis is a measure of the dose of curare which causes a 50 per cent block in the presence of the amount of potassium normally present in the bath.

It is clear, therefore, that as the temperature falls, the dose of curare required to cause a 50 per cent block is increased to such an extent by the potassium normally present in the preparation that about three times more curare is required at 25° C. than at 40° C.



RELATIONSHIP BETWEEN *d*-TUBOCURARINE CHLORIDE ADDED TO A 40-ML. BATH AND THE AMOUNT OF TYRODE SOLUTION CONTAINING 100 TIMES THE NORMAL AMOUNT OF POTASSIUM CHLORIDE REQUIRED TO MAINTAIN THE NEURO-MUSCULAR CONDUCTION IN THE PREPARATION IN A STATE OF 50 PER CENT BLOCK

to give the same effect. We therefore consider that the reversal of the action of curare with a fall of temperature is quantitatively explained by the second hypothesis mentioned above, namely, that curare is competing with naturally occurring potassium ions and that as the temperature is lowered the competition favours the potassium ion. Moreover, it provides an experimental basis for the understanding of the charge-density theory of the relationship between structure and action in drugs with curariform actions[4].

It is difficult to avoid the conclusion that, before it can block, curare must displace potassium, and that voluntary muscle possesses a powerful positive charge-seeking mechanism.

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and Physiology,
King's College,
University of London.

[1] Holmes, P. E. B., Jenden, D. J., and Taylor, D. B., *J. Physiol.*, **106**, 21 P.
[2] Ing, H. R., and Wright, W. M., *Proc. Roy. Soc.*, B, **109**, 337 (1932).
[3] Wilson, A. T., and Wright, S., *Quart. J. Exp. Physiol.*, **26**, 127 (1936).
[4] Holmes, P. E. B., Jenden, D. J., and Taylor, D. B., *Nature*, **159**, 86 (1947).

Hippuric Acid Formation from Glycine and Dibenzoylphosphate

MONOBENZOYLPHOSPHATE and dibenzoylphosphate were synthesized by letting benzoylchloride react with a mixture of silver phosphate and orthophosphoric acid in a way similar to that described by Lipmann[1] in his fundamental work on monoacetylphosphate.

Monobenzoylphosphate has been isolated as the disilver salt, $(C_6H_5CO)\ PO_4Ag_2$; dibenzoylphosphate as the crystalline sodium salt $(C_6H_5CO)_2PO_4Na$. Both

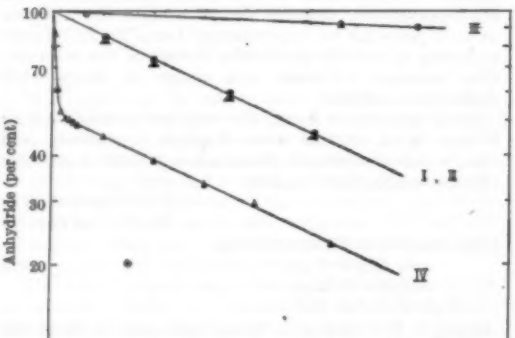
compounds undergo spontaneous hydrolysis in neutral aqueous solution. At 37° in *M*/30 phosphate buffer, *p*H 7·4, sodium monobenzoylphosphate has a half-life time of about 4½ hours. Sodium dibenzoylphosphate is much more stable: half-life about 45 hours under the same conditions. Both react with concentrated hydroxylamine (1 molar) at *p*H 7·4 to form one molecule of benzhydroxamic acid per anhydride group. The benzhydroxamic acid formed can be detected and determined in the form of its red complex ferric salt (max. absorption 525 mμ) (cf. Lipmann and Tuttle[2]).

At 37°, *p*H 7·4 monobenzoylphosphate does not react with glycine; however, one of the anhydride groups of dibenzoylphosphate reacts very rapidly with glycine, as can be seen from the following experiment.

The following mixtures were incubated at 37° C.:

(I) 5 ml. *M*/15 phosphate buffer, *p*H 7·4 + 5 ml. *M*/50 monobenzoylphosphate.
(II) 5 ml. *M*/5 glycine in *M*/15 phosphate buffer + 5 ml. *M*/50 monobenzoylphosphate.
(III) 5 ml. *M*/15 phosphate buffer, *p*H 7·4 + 5 ml. *M*/100 dibenzoylphosphate.
(IV) 5 ml. *M*/5 glycine in *M*/15 phosphate buffer + 5 ml. *M*/100 dibenzoylphosphate.

Samples were taken from time to time and the anhydride groups determined by the hydroxylamine method. In the accompanying graph, the results for I–IV have been plotted on a logarithmic scale against the time. It is evident that, under the experimental conditions, glycine has no influence on the breakdown of monobenzoylphosphate. The situation is, however, very different for dibenzoylphosphate. In the presence of glycine, half its anhydride groups disappear within a few minutes, and the residual groups break down at the same rate as monobenzoylphosphate.



Acetone-titration showed that NH_2-groups disappear during the reaction; hippuric acid formation has been qualitatively demonstrated by the partition chromatography method[3] using ethyl acetate and water as the two liquid phases.

The reaction can thus be written

$$(C_6H_5CO)_2\,PO_4^- + {}^+NH_3CH_2COO^- = C_6H_5CONHCH_2COO^- + C_6H_5COPO_4^- + 2H^+.$$

The corresponding reaction has been observed with ornithine and lysine too.

The present results serve to demonstrate that a peptide linkage can easily be formed by spontaneous non-enzymic reaction, from an amino-acid and a diacylphosphate, under physiological conditions (*p*H and temperature). It is suggested as a working hypothesis that diacylphosphates or substituted acylphosphates rather than mono-acylphosphates[4,5] could be the intermediary activated state of the carboxyl groups in the peptid-bond synthesis. It can easily be imagined that carboxyl groups of amino-acids, or their precursors, could be activated by phosphate groups bound to other cell constituents; special attention should be given to nucleic acids in view of the idea that they are involved in the protein synthesis[6,7].

It should also be pointed out that Lipmann[5] was unable to find any influence of monoacetylphosphate on the acetylation of sulphonamides, although the role of phosphorylation in the process strongly pointed to an intermediary formation of acetylphosphate. In the light of the results reported above, the failure of added monoacetylphosphate to act as acetylating agent could possibly be explained by assuming that the real phosphorylated agent is a substituted acetylphosphate.

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Methionine in Urine

In 1944 Albanese, Frankston and Irby[1] published their hydrogen peroxide – perchloric acid oxidation method for the estimation of methionine in protein hydrolysates and human urine. They stated: ". . . the applicability of the procedure to the urine was established by means of a study which demonstrated that the normal urinary constituents failed to react as methionine. This practice was further justified by the observations that the ingestion of *dl*-methionine by normal individuals resulted in a prompt elevation of the methionine level in the urine, as determined by our method. From a limited series of observations, it has been found that the normal adult (male) on a normal diet excretes 247 to 494 mgm. of methionine daily."

According to Cantarow and Trumper[2], the daily amount of amino-acid nitrogen in the urine ranges from 0·1 to 0·2 gm. Thus a daily output of 35 mgm. of amino-acid nitrogen (equivalent to 370 mgm. of methionine, average value) represents 23 per cent of the total amino-acid nitrogen (equivalent to 150 mgm., average value).

Under the direction of Dr. T. F. Dixon, many attempts were made in these laboratories to isolate the methionine from specimens of both human and pregnant mares' urine. The urines were titrated according to the method of Albanese, when methionine excretion values in the case of human urine came within the stated range. The horse urine averaged

440 mgm. of methionine per litre of urine. All attempts to isolate the methionine were fruitless, and the experiments were abandoned. Interest was revived, however, when Dent[3] showed that the filter-paper chromatography technique could be applied to human urine. He demonstrated the presence of at least two amino-acids of R_F values 0·37 and 0·57 (glycine and alanine ?). No mention was made of methionine, and presumably it was not revealed.

Experiments were then conducted in these laboratories in a further attempt to establish the presence of the amino-acid in normal urine. A pooled sample was divided into two equal parts, and to one was added solid *dl*-methionine, at a concentration of 0·25 mgm./ml. The two specimens were chromatographed side by side and finally treated with ninhydrin. If the claim made by Albanese *et al.*[1] had been correct then the colour intensity of the methionine spot in the sample of urine with added methionine should have been approximately twice that given by the original sample. The two papers were compared, when they were seen to differ by one intensely coloured spot, present in the sample containing added methionine. Nothing whatever could be observed in the corresponding position on the other paper.

It thus appears that methionine does not occur as such in normal urine. Presumably the titratable 'methionine' of Albanese *et al.*[1] is a conjugated form or derivative, the reducing properties of which correspond to those of methionine itself.

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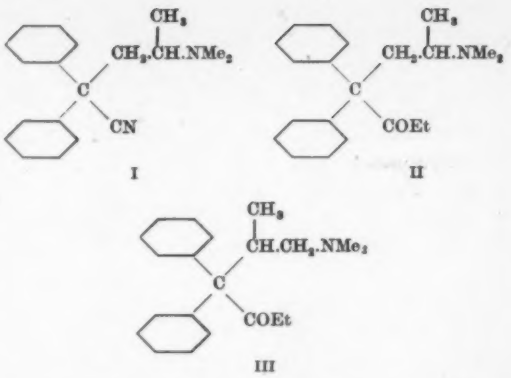
Optical Isomers of Amidone, with a Note on *iso*Amidone

l-AMIDONE has been briefly reported[1] to be an outstanding analgesic with about twice the activity of morphine, and this has recently been confirmed by us[2]. As no further chemical or pharmacological details appear to have been published, we give below a summary of our work in this field.

Attempts to resolve *dl*-amidone (II) using a number of optically active acids were unsuccessful. With *d*-tartaric acid it formed a diastereo compound, *dl*-amidone *d*-bitartrate, m.p. 128–133°, which crystallized unchanged from acetone and with alkali gave *dl*-amidone. The penultimate 1 : 1-diphenyl-3-dimethylaminovaleronitrile (I), on the other hand, was readily resolved by means of *d*-tartaric acid in wet acetone, from which the *l*-nitrile *d*-bitartrate (IV) crystallized in needles, m.p. 109–112°, $[\alpha]_D^{20} = +16°$



($c = 1·44$ in water). The corresponding *d*-nitrile *d*-bitartrate (V), m.p. 66–70°, $[\alpha]_D^{20} = +5°$ ($c = 1·62$ in water), was obtained from the acetone mother-liquors by recrystallizing the crude product from wet acetone-ether. The *l*- and *d*-nitriles from (IV) and (V) were readily converted into *l*- and *d*-amidone respectively by means of ethyl magnesium bromide. Comparative data for these bases and their salts are given in Table 1. It will be seen that the salts of the optically active nitriles have anomalous rotations in water.

In view of the recently published work on the chemistry[3] and clinical trials[4] of *iso*amidone (III), it may be added that we have also prepared and examined this compound in the form of its nitrate.

The pharmacological properties of *d*- and *l*-amidone have been compared and are briefly reported in Table 2, together with some preliminary observations on *iso*amidone. These results are more accurate than our earlier observations[2], since the same methods were used with two dose-levels for each compound and a larger number of animals at each treatment.

The two experiments on analgesic activity referred to in the table were cross-over tests on rats arranged so that each rat had each treatment of drug and dose once over a period of several days. The first experiment was made on a total of eighty rats, and in the second forty rats were used. Morphine was used as the standard of comparison in each case.

It will be seen that the lævo-isomer is the pharmacologically active form. (Although an increase in pain threshold was observed after large doses of *d*-amidone, there was no well-established dose : response relationship, and hence this is not regarded as evidence of true analgesia. The reason for the toxic property of *d*-amidone is not yet known.)

The respiratory depressant activity was determined on 9–12 rabbits for each compound at two dose-

TABLE 1

Ref. No.	Compound	Melting points					$[\alpha]_D$ Base in alcohol	Cation $[\alpha]_D$ $RNMe_2H^+$	
		Base	HCl	HBr	HI	HNO_3		in alcohol	in water
69C47	*dl*-nitrile	91	182	178	203	169	—	—	—
—	*l*-nitrile	100	—	215	199	176	− 51°	—	—
—	*d*-nitrile	101	—	216	—	—	+ 49°	+ 6°	− 7°
10820	*dl*-amidone	76	231	224	198	109	—	—	—
173C47	*l*-amidone	99	241	234	—	—	− 32°	− 169°	− 145°
193C47	*d*-amidone	99	240	234	175 dec.	148 dec.	+ 28°	+ 165°	+ 143°

TABLE 2

Compound	Analgesic activity				Respiratory depressant activity	
	Dose mgm./kgm.	Peak rise in pain threshold %		Activity ratio	Equi-active dose mgm./kgm.	Activity ratio
		Exp. 1†	Exp. 2†			
10820 (*dl*-Amidone)	2·4	61	—	1·3	2·5	1·4-2·0
173C47 (*l*-Amidone)	1·2	40	—			
	1·2	60	—	2·2	1·5	2·7-3·3
	0·8	30	—			
193C47 (*d*-Amidone)	20·0	33	—	<0·1*	>30·0	<0·1
	10·0	33	—			
Morphine	3·0	62	40	1·0	4–5	1·0
	2·0	43	22			
*iso*Amidone (442C47)	2·5	—	23	1·0	7-10	0·4-0·7
	1·5	—	16			

* See text note, p. 605.

† The two analgesic experiments are comparable with one another, since morphine was used as a standard of comparison in each case.

levels, but no effect was produced by *d*-amidone with doses comparable with those of the lævo-form. With a dose of 30 mgm./kgm. of *d*-amidone, approximately 30 per cent depression of respiration was seen.

Comparative experiments have been made with these compounds upon human volunteers, and the analgesic results in general resemble those given above for *d*-, *l*- and *dl*-amidone or morphine. The respiratory depressant action of *l*-amidone appears to be more than twice as great as that of *dl*-amidone, but *d*-amidone is almost without effect.

The toxic doses of the optical isomers of amidone upon intravenous injection in mice all lie between 15 and 18 mgm./kgm. for the L.D. 50 value, whereas the L.D. 50 for *iso*amidone nitrate is approximately 40 mgm./kgm.

In experiments upon the respiration of rat brain homogenate carried out by Dr. G. E. Glock, it was found that at concentrations of 0·005 *M*, *d*-, *l*- and *dl*-amidone produced similar degrees of inhibition of oxygen uptake of approximately 70 per cent. These results confirm those of Elliott[5] for amidone; but it should be pointed out that this concentration of drug is far greater than can be reached in the body after analgesic doses of these substances, and hence is of little practical significance.

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Acquired Resistance (Twofold) to Quinine in *Plasmodium gallinaceum*

AFTER the introduction of the newer synthetic antimalarials, the possibility of acquired resistance of plasmodium strains to these drugs became important, analytically and clinically.

Experiments to examine this question were started in April 1946. Naturally the communications by Bishop and Birkett[1] and by Williamson, Bertram and Lourie[2] were very interesting to me. In my series of experiments I started with quinine; then I tried to produce resistance to 'Paludrine', and I can confirm the possibility of resistance. Among the strains in my laboratory there is one (*Plasmodium gallinaceum*) which by administering seven times 4 mgm./kgm. 'Paludrine' weekly had acquired after some fifteen weeks a high degree of resistance to 'Paludrine'. In contrast with Williamson, Bertram and Lourie, I was able to produce in *Plasmodium gallinaceum* a moderate, nevertheless clearly demonstrable, resistance to quinine. My method was as follows: on Monday, blood inoculation (50 million parasites) in a 7-day-old chick. Oral administration of a minimum active dose of quinine once on Monday, twice on Tuesday, Wednesday and Thursday, totalling seven doses. On Friday the results were checked. On the following Monday, blood inoculation of the drugged strain, as on the previous Monday, etc.

To produce 40–50 per cent reduction of the percentage of infected erythrocytes, as compared to untreated control animals, a dose of 10 mgm./kgm. quinine-base (administered as hydrochloride) was found to be necessary; 20 mgm./kgm. (also administered seven times) caused nearly total reduction. These results agree with those of P. B. Marshall[3].

Originally 10 mgm./kgm. quinine was administered; after 12 weeks this dose failed to cause reduction. After 16 weeks the dose was increased to 20 mgm./kgm. Against this dose, too, there arose gradually (after a further sixteen weekly treatments) a resistance, so that it caused no reduction at all (see Table 1).

TABLE 1

Normal strain		Q 37	
Controls (undrugged)	Quinine, 20 mgm./kgm.	Controls	Quinine, 20 mgm./kgm.
81% (4) infected erythrocytes	0·9% (5)	78·7% (5)	75·2% (5)

Q 37 stands for 37 treatments with quinine, of 7 doses each. The number of birds in each experiment is given in brackets.

These results were repeated several times.

The quantitative estimation of this resistance was very important. Extensive experiments showed the resistance to be twofold: in the quinine-resistant strain, 40 mgm./kgm. quinine produced about the same action as 20 mgm./kgm. in a normal strain (see Table 2).

The increase of quinine resistance (twofold) is rather small as compared to 'Paludrine' resistance (40-fold);

TABLE 2

Normal strain			Q 51		
Controls	Quinine, 20 mgm./kgm.;	40 mgm./kgm.	Controls	Quinine, 20 mgm./kgm.;	40 mgm./kgm.
87% (12)	0·3% (10)	0·2% (9)	79% (10)	78% (10)	0·4% (10)
				Q 53	
	30 mgm./kgm.			20 mgm./kgm.;	30 mgm./kgm.
77 % (8)	0·1% (10)		63% (9)	56% (6)	18% (10)

experiments have been begun to ascertain if quinine resistance might be increased.

The essential difference between my experiments and those of Williamson, Bertram and Lourie is the fact that they used very large doses (150 mgm./kgm. daily in 516 out of 870 days) as compared to my doses of 20, later 40 mgm./kgm. daily, with three drugless days every week. How this difference bears on experiments with mepacrine, sulphadiazine and 3349 (I.C.I.) remains to be examined.

A further series of experiments served to examine if resistance is maintained after passage through the mosquito (*Aedes ægypti*) (see Table 3).

TABLE 3

Normal strain		Q 55 (through mosquito)	
Controls	Quinine, 20 mgm./kgm.	Controls	Quinine, 20 mgm./kgm.
87% (5)	0·2% (10)	43% (9)	8% (10)

Repetition of these experiments had the same results. So after one passage through the mosquito, acquired resistance to quinine is partially lost, in contrast with the persistence of acquired 'Paludrine' resistance. As regards quinine, this result agrees with those of Kritschewski and Halperin[4] (*Plasmodium relictum*), if one interprets their tables correctly.

The quinine-resistant strain appeared to be non-resistant to mepacrine, 'Paludrine' and chloroquine, because minimal active doses were as effective in the quinine-resistant strain as in a normal strain.

At present I am experimenting on the reaction of the secondary cinchona alkaloids and other anti-malarials. Also series of related experiments (inoculation of *EE* forms, loss of resistance, etc.) are in progress.

A detailed account of my results will be published later. I am indebted to the Imperial Chemical (Pharmaceuticals), Ltd., for the gift of 'Paludrine', and to the Nederlandsche Kininefabriek for the specially purified cinchona alkaloids. I am also grateful to Dr. F. Hawking (National Institute of Medical Research) for introducing me to the modern technique with *Plasmodium gallinaceum* and for putting a strain at my disposal; also to Dr. D. G. Davey, who demonstrated his laboratory technique. The experiments were carried out with the technical assistance of Miss Ella Pauw.

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Freezing as an Aid in the Drying and Purification of Humus and Allied Materials

IT is well known in colloid chemistry that the freezing of gels may cause coagulation, which is in some cases irreversible. We have found little evidence, however, that this phenomenon has been used to any great extent as a laboratory technique to simplify the bulk preparation of materials of a colloidal character.

In our work on soil organic matter, it is necessary to filter, reprecipitate and refilter frequently acid-precipitated flocculæ of humic acids (that is, materials allied to 'alkali-lignin' which constitute the bulk of soil organic matter). These materials, because of their large bulk, colloidal character and water-retaining capacity (greater than ten times their dry weight), are extremely difficult to filter and dry.

It has been found that, if the precipitates are frozen solid to a temperature of at least $-3°$ C. and then allowed to thaw, the colloidal properties are destroyed and the solid and aqueous phases separate. Moreover, the solid is in a condensed form, as irregular microscopic flakes, which are very readily filtered by standard methods.

The moisture content of a humus preparation has been reduced to one thirtieth of the original by a single freezing and thawing.

The colloidal character of the materials having been destroyed, they not only lose their water-holding capacity but also their general adsorptive power. Therefore, by washing with water, soluble contaminants are readily removed and a considerable degree of purification attained.

The presence of electrolytes is necessary for the freezing effect to take place, since in their absence the material reverts to its colloidal form on thawing.

The condensed humus can be regenerated in normal form by solution in alkali and precipitation with acid. The raw materials (soil, peat, or decomposed vegetable matter) are extracted with dilute (2 per cent) caustic soda and the alkaline extract acidified with sulphuric acid to a *p*H of approximately 3. The precipitated humus is allowed to settle, and after the supernatant liquor has been siphoned off, is frozen to $-3°$ C. It is then allowed to thaw, filtered, washed, and because of its small bulk and non-adsorptive powers is readily completely dried by standard methods.

The method is applicable to materials of similar properties such as 'alkali-lignin' precipitated from the waste liquors in the soda process, and may indeed have wide application in simplifying the preparation of plant structural substances in a readily handled form.

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Effect of Oxygen on the Frequency of Chromosome Aberrations Produced by X-Rays

MOTTRAM[1] demonstrated that the effect of gamma- and X-radiations in inhibiting the growth of *Vicia faba* root tips was materially reduced if the exposure was made under anaerobic conditions, and that the change in radiosensitivity could not be correlated with a change in the proportion of cells in division at the time of irradiation. Crabtree and Cramer[2] had previously shown a similar effect of anaerobiosis on the radiosensitivity of tumour cells.

We have confirmed Mottram's result by irradiating with X-rays (H.V.L. 1 mm. Cu) groups of beans with their roots in a 'Perspex' cell of water through which nitrogen was bubbled. The cell was placed in a cardboard box with small holes for the egress of the nitrogen to minimize back diffusion of air. The nitrogen was bubbled for ten minutes, the radiation was given in the next ten minutes, and the bubbling of the nitrogen, which had continued during the irradiation, was kept on for five more minutes. The beans were then returned to the culture tank, where they were always in darkness to avoid a daily mitotic rhythm. Doses of 320 r., 255 r., and 175 r. were given to three groups, while three other groups were treated identically, but air was bubbled instead of nitrogen. In no case did the temperature of the water drop by more than 2° C. from the 19° C. of the culture tank. The growth curves of the nine beans in a group have been averaged and are plotted in Fig. 1, which illustrates the striking effect of the anaerobiosis on the radiosensitivity.

Experiments are in progress here to test Gray's[3] hypothesis that the lethal effect of ionizing radiations on the growing tip of the *Vicia faba* root is due to the genetic abnormalities which result from the division of cells containing aberrant chromosomes.

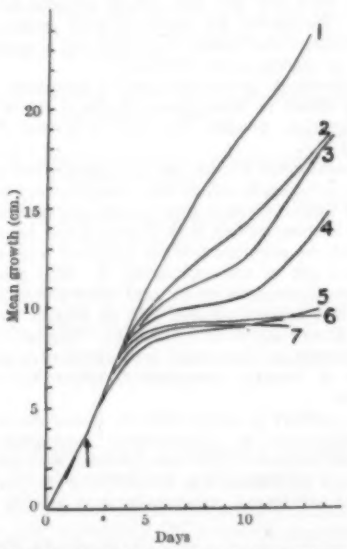

Fig. 1. EACH CURVE IS THE AVERAGE OF THE GROWTH CURVES OF A GROUP OF NINE ROOTS OF THE BROAD BEAN (*Vicia faba*) TREATED AS FOLLOWS ON THE SECOND DAY:

(1) 175 r. in nitrogen; (2) 255 r. in nitrogen; (3) 320 r. in nitrogen; (4) 175 r. in air; (5) 175 r. in oxygen; (6) 255 r. in air; (7) 320 r. in air

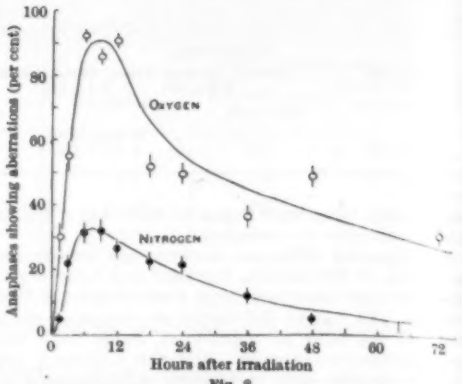

Fig. 2.

Upper curve—143 r. in oxygen; lower curve—143 r. in nitrogen

The results so far have been in agreement with this view, and it was therefore believed that the decrease in radiosensitivity of the root tips in nitrogen should be accompanied by a parallel decrease in the proportion of cells having chromosome aberrations. Groups of beans have therefore been irradiated, as described above, except that the exposure time was reduced to 4 min. to match earlier experiments. The dose was 143 r. In the case of half the groups nitrogen was bubbled, and for the other half oxygen (not air). Again the temperature did not drop by more than 2° C. Tips were fixed at intervals up to 72 hours after the exposure; Fig. 2 shows the percentage of anaphases in which there were visible bridges or fragments. All but two of the points are based on 100 anaphases studied in each of two root tips. The yield of chromosome aberrations is also strikingly less when the irradiation is done in an atmosphere of nitrogen. As a similar reduction of radiosensitivity, as measured by growth subsequent to irradiation, was observed when nitrous oxide, carbon dioxide, and hydrogen were substituted for nitrogen, it seems clear that the availability of oxygen is a very important factor in the production of chromosome aberrations. It is possible that the effect of temperature observed by Sax and Enzmann[4], and Catcheside *et al.*[5], and the effect of *p*H observed by Marshak[6] may, at least in part, be due to differences in the availability of oxygen. That the radiosensitivity of tumours is affected by oxygen supply has long been suspected. It now seems likely that this influence does act through the effect on the production of chromosome aberrations.

The details of these experiments and a full discussion will be published later. This preliminary report is given to direct the attention of those studying the production of chromosome aberrations by radiations to the importance of controlling the oxygen supply.

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Initial Parenchyma Cells in Dicotyledonous Woods

STUDIES on living trees have shown that the concentric bands of parenchyma cells found in the diffuse-porous wood of *Terminalia tomentosa* W. and A.[1,2] are initial, that is, they are formed as the first tissues of a growth season. Some similarity between these parenchyma cells and those that occur in the early wood of ring-porous timbers was recognized, and in one specimen of *Terminalia tomentosa* W. and A.[2] a tendency to form semi-ring-porous structure was noticed, but nothing more than this was known at that time. Recently I have, however, come across some wood specimens of *Gmelina arborea* Roxb. which show not only both diffuse-porous and ring-porous structure but also some intermediate stages between these two extremes.

When *Gmelina arborea* Roxb. has a true diffuse-porous wood, the initial parenchyma cells may be altogether absent, although the growth rings may be visible due to the difference in the thickness of the fibre wall of early wood and that of the late wood of the previous year (Fig. *a*). In the first stage towards ring-porosity, the timber remains a diffuse-porous wood, but in between the early fibres and the late fibres of the previous year, a thin layer of initial parenchyma cells is usually present (Fig. *b*). This is exactly what was originally found in *Terminalia tomentosa* W. and A.[1]. At this stage, there may not be any appreciable difference between the size of the vessels within a growth ring, and the early vessel may not come in contact with the initial parenchyma cells. In the next stage, the timber has a semi-ring-porous structure. The somewhat large and scattered early vessels are partially embedded in the initial parenchyma cells. Finally, the timber shows a true ring-porous structure, where a clear row of large vessels are partially or wholly embedded in the initial parenchyma (Fig. *c*). Thus the part played by the initial parenchyma cells in the transformation of diffuse-porous wood to ring-porous wood is quite evident.

In tracing the development of initial parenchyma cells, it seems possible to detect some physiological cause for their formation. Forsaith[3] and Huber[4] have shown that rigour of growth condition is responsible for the formation of ring-porous timbers. It is therefore possible that *Gmelina arborea* Roxb. produces true diffuse-porous timbers when the growth conditions are mild, and semi-ring-porous to true ring-porous timbers when the conditions of growth are slightly to greatly severe. The capacity to vary its anatomical structure to suit the growth conditions would appear to be of a great help in maintaining its wide distribution.

Since the discovery of initial parenchyma cells in the wood of *Terminalia tomentosa* W. and A.[1], researches carried out at the Forest Research Institute, Dehra Dun, and elsewhere have shown that there are many diffuse-porous woods which have initial parenchyma cells; for example, *Dalbergia sissoo* Roxb.[5], *Swietenia macrophylla* King[6], *Salix matsudana* Koidz[7], and *Entandrophragma macrophyllum* A. Chev.[8]. On the other hand, some American workers[9] have questioned the validity of my original observations on *Terminalia tomentosa* W. and A. Based on some incomplete material collected from a few members of the Juglandaceæ, they were not able to decide whether to call these parenchyma cells terminal or initial. However, researches carried out in this laboratory have shown that the initial parenchyma cells are often a generic character and may in some cases be even a family character. Details of this investigation will be published elsewhere.

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Aug. 9.

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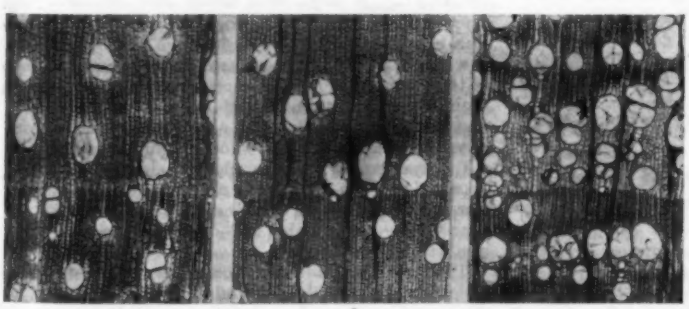
[2] Chowdhury, K. A., *New Phyt.*, **35**, 4 (1936).
[3] Forsaith, C. C., *Ecology*, **1**, 2 (1920).
[4] Huber, B., *Deutsch. Bot. Ges.*, **53**, 8 (1935).
[5] Chowdhury, K. A., *Indian For. Rec.* (n.s.), (*Utilization*), **2**, 2 (1940).
[6] Chowdhury, K. A., *Indian For. Rec.* (n.s.), (*Utilization*), **2**, 3 (1940).
[7] Chang, Y., private communication (1936).
[8] Hummal, F. C., *Emp. For. Rev.*, **25**, 1 (1946).
[9] Heimsch, C., and Wetmore, R. H., *Amer. J. Bot.*, **26**, 8 (1939).



a *b* *c*

VARIATION IN THE RING-POROSITY OF *Gmelina arborea* ROXB.: (*a*) TRUE DIFFUSE-POROUS; (*b*) DIFFUSE-POROUS WITH INITIAL PARENCHYMA CELLS; (*c*) TRUE RING-POROUS. × 20

Willow as Host-Plant of *Crioceris merdigera*

A SHORT note by Mr. J. Saulnier in *Miscellanea Entomologica*, **43**, July 1947, p. 43, is headed "L'osier est-il une nouvelle plante hôte de *Crioceris merdigera* Linné ? (Chrysomelidæ, Coleoptera)". On two occasions he has found this chrysomelid beetle on osier willow (*Salix viminalis* L. Salicaceæ), once on July 6, 1943, at La Booz, near Bretoncelles, Orne, and again on April 28, 1946, at Berdhuis, Orne. At first he thought it was accidental, but having found it a second time a note asking the above question seemed justifiable.

In order to understand the relationships between the insect and its host-plants, it is necessary to consider the group as a whole; the host-plants of a single species of beetle constitute a datum which cannot by itself suggest relationships. According to the tables in my book (not yet published) the largest number of the Criocerinæ occurs on species of Gramineæ and Liliaceæ. Criocerine beetles have also been found on plants of families Commelinaceæ, Dioscoreaceæ, Orchidaceæ, Salicaceæ, Solanaceæ, Cucurbitaceæ, Compositæ and nine others.

There is one record of a criocerine beetle (*Lema lichenis* Voet = *Lema cyanella* Suffra. = *Crioceris cyanella* L.) attacking willows (see Fowler, "Coleoptera

of the British Islands", p. 282; 1890). Mr. Saulnier's find is further evidence in support of the principle that when one species of a group of insects has been found to occur on a plant, others of the group may also be expected to occur on it.

Although the particular species which Mr. Saulnier has found on a willow has not been reported from that host before, the occurrence is thus not altogether unexpected.

S. MAULIK

British Museum (Natural History),
London, S.W.7. July 12.

Preparation and Properties of 3-Ethyl-5:5-dimethyloxazolidine-2:4-dione

IT is stated by Spielman[1] that 3 : 5 : 5-trimethyloxazolidine-2 : 4-dione can be prepared by methylating 5 : 5-dimethyloxazolidine-2 : 4-dione in aqueous alkaline solution with dimethyl sulphate. Spielman failed to obtain the 3-ethyl analogue by this method using diethyl sulphate. A product, m.p. 61–62°, which was regarded as the 3-ethyl analogue, was, however, obtained by the action of ethyl iodide on the silver salt of 5 : 5-dimethyloxazolidine-2 : 4-dione.

It is now found that by treating the sodium salt of the dimethyloxazolidinedione in alcoholic solution with diethyl sulphate or with ethyl iodide, the 3-ethyl derivative is readily obtained. It melts at 76–77° and is not identical with the product obtained by the silver salt method. Thus the product, m.p. 76–77°, is stable to aqueous hydrochloric acid and with aqueous sodium hydroxide yields the sodium salt of N-ethyl-N-α-hydroxyisobutyrylcarbamic acid; whereas the product, m.p. 61–62°, is unstable to hydrochloric acid, yielding the original 5 : 5-dimethyloxazolidine-2 : 4-dione, and also to aqueous sodium hydroxide, yielding the sodium salt of the 5 : 5-dimethyloxazolidinedione.

The product m.p. 76–77° is regarded as being the true 3-(or N-)ethyl derivative, and that of m.p. 61–62° as an O-ethyl derivative of an enolic form of 5 : 5-dimethyloxazolidine-2 : 4-dione.

Further support for this view is found in the facts that the O-ethyl compound is readily converted to the N-ethyl compound by the action of heat and to the N-methyl, N-ethyl and N-benzyl derivatives when heated with methyl iodide, ethyl iodide and benzyl bromide, respectively.

Pharmacological tests carried out in these laboratories indicate that the 3-ethyl derivative is an anti-convulsant having an activity of the same order as that of the 3-methyl derivative.

W. H. HOOK

British Schering Research Institute,
Brook Lane, Alderley Edge,
Cheshire. June 30.

[1] Spielman, *J. Amer. Chem. Soc.*, **66**, 1244 (1944). See also B.P. 561183.

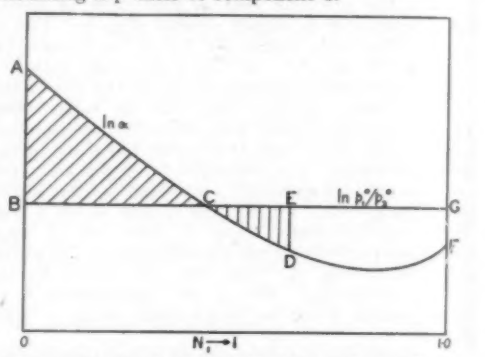
A Thermodynamic Test for the Internal Consistency of Experimental Data on Volatility Ratios

AN important measurable parameter in the study of vapour-liquid equilibria in two-phase binary mixtures is the volatility ratio (α) defined by $N_1^g.N_2/N_1.N_2^g$, where N_1^g is the mol fraction of component 1 in the vapour and N_2 that of component 2, while N_1 and N_2 are the corresponding quantities for the liquid. In view of the difficulties inherent in the determination of α, the need for a thermodynamic test of the reliability of experimental data has been expressed[1]. In this note such a test will be described and also a method given for deriving ΔG^E from the curve of α plotted against N_1, where ΔG^E is the excess free energy of formation of the mixture over an ideal mixture of the same composition. A study of this quantity (ΔG^E) is fundamental to the investigation of the structure of liquid mixtures.

The considerations will be restricted to the case where the vapours may be treated as ideal gases and where the molar volumes of the liquids may be neglected in comparison with that of the vapours. The expression can readily be modified to remove these restrictions, but when they are applicable it can be shown that equation (1) holds for isothermal conditions.

$$RT\int_0^{N_1^1}(\ln\alpha - \ln p_1^\circ/p_2^\circ)\,dN_1 = \Delta G^E_{N_1^1}, \qquad (1)$$

In this equation p_1° and p_2° are the vapour pressures of the pure components at $T°$ absolute and $\Delta G^E_{N_1^1}$ is the excess free energy of formation of the mixture containing N_1^1 mols of component 1.



The accompanying graph illustrates the application of this equation to the calculation of $\Delta G^E_{N_1^1}$ from experimental results. The area *ABC* minus the area *CDE* represents the integral on the left-hand side of the above equation, and this when multiplied by *RT* yields $\Delta G^E_{N_1^1}$. The areas bounded by the ln α curve which lie above the line $\ln p_1^\circ/p_2^\circ$ are counted positive, those below negative.

An important special case arises when $N_1^1 = 1$ for $\Delta G^E_{N_1^1=1}$ is zero, and hence the left-hand side of equation (1) is also zero, that is, the algebraic area bounded by $N_1 = 0$ and $N_1 = 1$ and the curves ln α and $\ln p_1^\circ/p_2^\circ$ is zero when the above convention as to sign is employed. Thus, in order that the data shown in the graph should be thermodynamically consistent (subject to the above restrictions) it is necessary that area *ABC* should equal area *CDFGE*.

In practice, the ln α against N_1 curve has to be extrapolated to $N_1 = 0$ and $N_1 = 1$, which can usually be done with little error. The areas may be found either with the aid of a planimeter or by quadrature.

This test for the internal consistency of data refers strictly only to values found under isothermal conditions, but may be usefully applied in a semi-quantitative manner to isobaric data if the components are a close-boiling pair. Here the values

of ln p_1^0/p_2^0 appropriate to the boiling point of the mixtures are plotted against N_1. The equation applicable to isobaric data when the components differ considerably in boiling point is rather more complex.

The derivation of equation (1) and examples of its use in the investigation of the systems thiophene – benzene and ethylene dichloride – benzene will be published elsewhere.

I am indebted to Dr. R. P. Linstead, director of the Chemical Research Laboratory, for permission to publish this note.

E. F. G. Herington
Chemical Research Laboratory,
Teddington, Middlesex.
July 11.

[1] Carlson and Colburn, *Ind. Eng. Chem.*, **34**, 1533 (1942).

Hydrodynamics of Non-Newtonian Fluids

If the assumption is made that a fluid is incompressible, then the most general possible relations between the stress components ($t_{xx}, t_{yy}, \ldots$) and the strain-velocity components ($a, b, \ldots$) can be obtained as

$$t_{xx} = 2\Theta.a + 2\Psi.A' + p \ldots,$$
$$\text{and} \quad t_{yz} = \Theta.f + \Psi.F' \ldots \quad (1)$$

($a, \ldots f, \ldots$) are given, as in classical hydrodynamics, by

$$a = \partial u/\partial x \ldots \text{ and } f = \partial v/\partial z + \partial w/\partial y \ldots,$$

where (u,v,w) are the components of velocity at a point (x, y, z). ($A_1', \ldots F_1', \ldots$) are given, in terms of ($a, \ldots f, \ldots$), by the relations

$$A' = a^2 + \tfrac{1}{4}(g^2 + h^2) \ldots$$
$$\text{and} \quad F' = \tfrac{1}{2}gh + (b + c)f \ldots \quad (2)$$

p is a hydrostatic pressure. Θ and Ψ are arbitrary functions of the strain-velocity invariants K_2 and K_3, where

$$K_2 = ab + bc + ca - \tfrac{1}{4}f^2 - \tfrac{1}{4}g^2 - \tfrac{1}{4}h^2$$
$$\text{and } K_3 = abc + \tfrac{1}{4}fgh - \tfrac{1}{4}af^2 - \tfrac{1}{4}bg^2 - \tfrac{1}{4}ch^2.$$

The invariant $K_1 (= a + b + c)$ is zero, since the fluid is incompressible.

The stress *vs.* strain-velocity relations (1) are somewhat similar to those obtained by Reiner[1] for a compressible fluid.

For a Newtonian fluid, $\Psi = 0$ and Θ is a constant—the viscosity of the fluid. For a non-Newtonian fluid, Θ depends on the strain-velocity invariants K_2 and K_3. It appears, from (1), that for a general, incompressible fluid, there is a second physical parameter Ψ which must be specified in order to define completely the flow properties of the fluid. This, again, may be a constant, or may depend on the strain-velocity invariants K_2 and K_3.

Equations (1) have been applied to calculate the forces which must be exerted on the boundary surfaces of a general, incompressible fluid in the following two cases.

(i) A cylindrical mass of fluid is subjected to a single torsional motion, in which each point of the fluid moves in a circular path about the axis of the cylinder, in a plane at right-angles to it, its angular velocity ψz being proportional to its distance z from one end of the cylinder.

(ii) A mass of fluid is contained between two coaxial cylinders, which are rotated with respect to each other about their common axis, and each point of the fluid moves in a circular path about this axis, in a plane at right-angles to it, with an angular velocity Ω, which depends only on the distance from the axis.

In case (i), it is found that in order to produce the specified motion of the fluid, both azimuthal and normal surface tractions must be exerted on the plane ends of the cylinder. If Ψ is constant, then the normal surface traction Z which must be exerted at a point at a distance r from the cylinder axis is given by

$$Z = \tfrac{1}{4}\Psi\psi^2 (3r^2 - a^2), \quad (3)$$

where a is the radius of the cylindrical mass of fluid.

In case (ii), it is found that in order to produce the specified motion of the fluid, azimuthal surface tractions must be exerted on the cylindrical surfaces of the fluid, and normal surface tractions Z must be exerted on the plane-free surfaces. If Ψ is constant, the value of Z at a distance r from the common axis of the cylinders is given by

$$Z = -2\Psi(\Omega_1 - \Omega_2)^2 \left(\frac{a_1^2 a_2^2}{a_1^2 - a_2^2}\right)^2 \frac{1}{r^4}; \quad (4)$$

a_1 and a_2 are the radii of the inner and outer confining cylinders and Ω_1 and Ω_2 are their angular velocities.

In the calculations of both cases (i) and (ii) it is assumed that centrifugal and gravitational effects can be neglected. It is seen, from (3) and (4), that if $\Psi = 0$, $Z = 0$ for both systems. The effects which arise from the non-vanishing of Ψ are similar to those obtained by Weissenberg[2] with a variety of fluids. It does not appear, however, that his explanation of these effects can be a valid one, since it depends on the presence of an elastic component in the stress *vs.* strain relations for the fluid, which could not make itself evident in any experiment on steady-state flow. From the point of view of phenomenological theory, such effects can arise in a material which is not visco-elastic. Whether or not materials which show this effect are, in practice, visco-elastic is a matter which must be decided either on experimental grounds or by studying the dependence of Ψ and of rigidity on the constitution of the fluid.

This work was carried out as part of a programme of fundamental research undertaken by the board of the British Rubber Producers' Research Association, while I was a guest worker at the National Bureau of Standards, Washington, D.C. It is hoped to publish a fuller account elsewhere.

R. S. Rivlin
British Rubber Producers' Research Association,
Welwyn Garden City,
and
National Bureau of Standards,
Washington, D.C.

[1] Reiner, M., *Amer. J. Math.*, **67**, 350 (1945).
[2] Weissenberg, K., *Nature*, **159**, 310 (1947).

A Long-Term Plan for the Nile Basin

In an article on "The Nile Basin", vol. 7, in *Nature* of August 16, p. 215, Dr. C. E. P. Brooks directs attention to the fact that the theory underlying what we have called 'century storage' is not given in the book. This was omitted because it was thought better not to make a book dealing with Nile projects more difficult by including in it complicated theoretical investigations. It is the intention to publish a full account of these separately; but it may be opportune to give here a very short summary of what has been done, and also to clear up a point raised by Dr. Brooks as to the correctness of the

formula: $R = 1{\cdot}65\ \sigma\sqrt{N}$, on which our scheme of projects depends. This relates to a set of N observations the frequency distribution of which is approximately Gaussian when no account is taken of their order, σ being the standard deviation and R the maximum accumulated excess or deficit of departures from the mean. In the case of a river discharge, R is the amount of storage required to meet accumulated deficits over a period N. The equation gives the mean value of R obtained from 71 sets of observations of river discharges, river levels, rainfall, temperature and pressure covering periods of from thirty to two hundred years, with two or three cases outside this range, and a mean period of 97 years.

The form of the equation was obtained by considering the case of tossing a set of coins N times when the result is equal numbers of heads and tails. The frequency distribution is approximately Gaussian for a set of ten or more coins. If there fall n heads and n tails, the number of orders in which this can occur is $2nCn$. Among these orders there are $2nCn+h$, in which at some point heads exceed tails by h or more (Whitworth, "Choice and Chance"). By giving h all values from 0 to n, a mean value for the maximum excess of heads over tails can be found. Using Stirling's approximation for $n!$ we find:

$$R = \sqrt{n\pi} = \sigma\sqrt{\tfrac{1}{2}N\pi} = 1{\cdot}25\,\sigma\sqrt{N}.$$

This is a first approximation and was verified practically by tossing 10 sixpences 1,000 times, with the following results:

N	Number of sets	Mean value of $R/\sigma\sqrt{N}$
100	10	1·11
500	2	1·26
1,000	1	1·19

It is to be noted that owing to approximations the above result does not hold for small values of N.

The investigation relates to sequences of chance events where there is no relation between one member and another. Meteorological elements, however, often show periods when, on the whole, values are high, and others when they are low. The tendency of this grouping is to give higher values for R than those found for purely chance distributions, and is the explanation of the difference between the mean values of 1·25 and 1·65 for $R/\sigma\sqrt{N}$ found for chance events and natural phenomena.

The variation of R with N for natural phenomena was examined, but the lack of records covering long periods made it impossible to distinguish practically between $R \propto N$ and $R \propto \sqrt{N}$, so the form arrived at for chance events was naturally adopted. Dr. Brooks agrees that the difference between the two formulæ is not serious from a practical point of view, and actually it is much less than he has calculated from the incomplete data on the diagram in the book.

Some discussions with Dr. W. Lawrence Balls had directed attention to a fundamental theoretical question arising out of the investigation; that is, what are the statistical properties of natural phenomena such as river discharges, rainfall, etc., having regard to their order of occurrence? Dr. Brooks' remarks lead also to this question. So far as the practical affair of water storage, which led to the investigation, is concerned, we have given a satisfactory solution which covers periods up to one or two centuries. It is this solution which has enabled us to draw up for the first time a detailed scheme of irrigation projects for the full development of Egypt and the Sudan. The scarcity of records covering several centuries and the mathematical difficulties have, however, so far prevented us from giving a complete theoretical solution, though work is continuing on this. Dr. Brooks has kindly supplied us with a series for 4,000 years of the thickness of annual mud deposits in Lake Saki, and the examination of these and of the Carnegie Institution data about tree rings may lead to interesting results. References to other long series of observations would be valuable to us.

H. E. Hurst
R. P. Black
Y. M. Simaika

Ministry of Public Works,
Cairo.

The Missing Factor in Science

Prof. H. Dingle, in his inaugural lecture at University College, London[1], has done me the honour of coupling my name with that of the late Sir Arthur Eddington as horrible examples of distinguished thinkers "making statements of the greatest import which even an intelligent child can see to be directly contradicted by the facts".

Unfortunately the statement ascribed to me that science is "the means of obtaining practical mastery over nature through understanding it" represents such a gross distortion of my expressed attitude towards the question that I cannot let it pass without protest. As any reader of my book[2] can see for himself, I have held that this view only represents one aspect of science which has to be taken account of in assessing the total significance of science. Though it is impossible to condense adequately the significance of such a complex activity as science in a few sentences, the following quotation from my final chapter does expose the superficiality of Prof. Dingle's judgment:

"We have seen science as an integral part both of the material and economic life of our times and of the ideas which guide and inspire it. Science puts into our hands the means of satisfying our material needs. It gives us also the ideas which will enable us to understand, to coordinate, and to satisfy our needs in the social sphere. Beyond this science has something as important though less definite to offer: a reasonable hope in the unexplored possibilities of the future, an inspiration which is slowly but surely becoming the dominant driving force of modern thought and action."

If I had said—which I have not—that science was *nothing but* "the means of obtaining practical mastery over nature", Prof. Dingle might justly reproach me with omitting many other weighty aspects. Curiously enough, this is not what he tries to do. Instead, he sets himself the impossible task of proving that science is not concerned with such mastery. It is therefore not surprising to find that of the four simple tests which he uses to disprove my alleged definition, the first and last are false, the second irrelevant and the third unscientific.

It is clearly not the acceptance criterion of scientific papers that can be expected to show the purpose of science, but their content and the aim revealed in each investigation. In the very copy of *Nature* in which this article appears there are nineteen communications of original research; of these no less than ten are directly concerned with the mastery of man over nature, as for example a letter on "Disease

of Pyrethrum in Kenya", and all the remainder, with the possible exceptions of "Feeding Mechanisms of Water Bugs" and the "Individual Activities of Ants", are examples of "understanding of nature" only one remove from practical requirements. Lest this should be thought a reflexion on the purity of *Nature*, an examination of the last two numbers (1020 and 1021) of that most austere of scientific publications, the *Proceedings of the Royal Society* (A), shows an even greater proportion—11 : 8—of papers directly devoted to the mastery of nature. The criterion of acceptance of these papers is that they should be, as far as may be judged by competent men, significant and accurate, for these are necessary though not sufficient conditions for the effectiveness of action based on them.

Equally unreliable is Prof. Dingle's last criterion of the achievements of the recipients of prizes and medals. It is only necessary to look at the citations to see how often the value of the new knowledge to humanity is stressed.

As to Prof. Dingle's second criterion, the questions in the examination papers, it has nothing to do with the argument. However much we may deplore it, examinations to-day are designed to test competence and knowledge, not purpose.

It is the third criterion that is most surprising, particularly coming from Prof. Dingle, for it is neither more nor less than his old bugbear—the appeal to the authority; and not even to that of the fathers of the Church, of the founders of the Royal Society—but to the literary authors of the New English Dictionary. Neither they nor the authorities from which they collected their readings had any object beyond the fixing of commonly accepted meanings. When the compilation is done again, undoubtedly the new definition of science as "mastery over nature" will be cited, though I hope it will be attributed to Prof. Dingle and not to me.

Now it would not have been worth writing this letter if it was not for the fact that the very disagreement between Prof. Dingle and myself over definitions and proofs is the strongest argument for the need to provide for the undertaking of criticism of science which Prof. Dingle urges in the latter part of his address. I may find his arguments as feeble and wrongheaded as he finds mine childish and tragic, but we both agree that the question is important and that we must train, pay and honour those who devote themselves to an attempt to answer it.

We need a recognition of a science of science, of which the study of the history of science will provide the initial descriptive base, but which itself is pursued like other sciences by research and experiment. The motives, incentives, methods and organisation of science all need study by research teams. The sooner we realize that such investigation is as good science as any other, the sooner we shall cease to waste our time in muddle and controversy and get on with the job of science, whatever it may be found to be.

J. D. Bernal

Birkbeck College
(University of London),
London, E.C.4.

[1] *Nature*, **160**, 108 (July 26, 1947).
[2] "The Social Function of Science", by J. D. Bernal (Routledge, 1939).

I am very glad indeed to know that Prof. Bernal supports my plea for criticism in science, and only slightly less so to learn that he disowns the view of science I ascribed to him. My article would have been worth writing for these results alone.

He implies, however, that I have distorted his previous writings; but re-reading confirms the first impression, which is not modified by the passage now quoted. Science is there described as an integral part of economic life and as offering a vague hope for the future, and this hope is presumably what he now emphasizes. But I was speaking of what science *is*, not of the many things it may be held to 'offer'. Unfortunately, lack of space demanded severe abridgment of my lecture, and I would ask those who feel that certain passages need qualification to read the full text just published by Messrs. H. K. Lewis and Co. It shows my awareness that science *can be used* for material ends, and Prof. Bernal's statement that I try to prove that science is "not concerned" with mastery over nature is, therefore, misleading. Our difference is perhaps best revealed by his statement that the criterion of acceptance of papers is significance and accuracy, "for these are necessary . . . conditions for the effectiveness of action based on them". I hold that the criterion is "significance and accuracy" irrespective of whether action can be based on them or not.

I cannot accept Prof. Bernal's criticism of my tests for the nature of science. I still maintain that the "acceptance criterion" and not "content and aim revealed" (in so far as these are separable from the acceptance criterion) is the proper clue to the meaning of science; indeed, it seems to me obvious. *Nature* is not the kind of journal I mentioned. I do not agree with Prof. Bernal's analysis of the last two numbers of the *Proceedings of the Royal Society* (A), but I am astonished that, after declaring that "the history of science will provide the initial descriptive base" of the study of science, he should base his own arguments on the last two numbers of the *Proceedings of the Royal Society*, and the next edition of the New English Dictionary. I did not expect to find him so "deceived by the momentary appearance of a movement which after taking 2,000 years to prepare itself, has been gathering momentum for the last 300 years". It would surely not be surprising if, after several years in which all scientific effort was perverted to a particular end and kept secret, the early succeeding papers should show an abnormal possibility of practical application, though I maintain again that that would not be why they would be accepted for publication and, therefore, would not be the clue to the 'science' in them.

Finally, I am puzzled to know why Prof. Bernal, while acknowledging that the New English Dictionary merely gives "commonly accepted meanings", should charge me with "appealing to authority" by referring to it. I turned to it for "commonly accepted meanings", assuming that, if Prof. Bernal's book was to be trusted, the "mastery over nature" view should be there. His book states (p. 6) that that view (now described as "new" and attributable to me) was present in classical times, appears explicitly in Roger Bacon and at the Renaissance, and is fully expressed in its "modern" form by Francis Bacon. "This," he adds, "remained the predominant view of science for at least two hundred years." Why is it not mentioned in the Dictionary, and why will it "undoubtedly" appear next time?

Herbert Dingle

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VALVE WITH TROCHOIDAL ELECTRONIC MOTION

By Prof. H. ALFVÉN and H. ROMANUS
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IN a homogeneous magnetic field an electron with a velocity perpendicular to the field moves in a circle. If an electric field is applied perpendicularly to the magnetic field, the circle 'drifts' with a velocity which to a first approximation (electric field not too strong) is

$$\mathbf{v} = -\frac{c}{H^2}\mathbf{H} \times \mathbf{E}.$$

The combined motion is a cycloid or trochoid. As the drift is perpendicular to the electric field, the circle in which the electron moves is displaced along *an equipotential line*.

If a beam of electrons moving in cycloids or trochoids is produced, this beam follows that equipotential line on which it started. As in a valve an equipotential line is easily changed and can be given almost any desired shape, a trochoidal beam possesses a high flexibility and can be used for many technical purposes, for example, the construction of electronic switches and counters.

During recent years research on valves with cycloidal or trochoidal electronic motion has been carried out at this laboratory. The development of the valves, which are called 'trochotrons', has been carried out by G. Hambraeus and, especially, T. Wallmark. Different circuits for the valves have been worked out by Lindberg, Lundquist, Warring and Åström.

The type of valve mostly used at present is shown diagrammatically in Fig. 1.

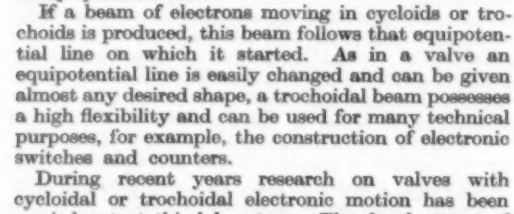

Fig. 1

A homogeneous magnetic field (100–200 gauss) is applied perpendicular to the plane of the paper. The filament 1 emits electrons which are attracted by the anode 2. Due to the magnetic field, however, they never reach the anode. Instead, a trochoidal beam is formed travelling along an equipotential line of the electric field formed between the electrode 3, which is held at zero or negative potential, and the electrodes 4–15, normally given positive potentials of 100–200 volts. The whole current emitted (about 1 mA.) is thereby received by the 'plate' 4.

If the potential of one of the electrodes 5, 7, 9, 11, or 13 (the 'guides'), for example, that of 9 is decreased to about 20 volts or lower, the equipotential line followed by the beam enters the box between 9 and 11. The current goes to plate 10, and in part also to guide 9. If this is connected to the voltage supply through a resistance R, the voltage drop in R will maintain the low potential on the guide. Consequently, if once *the beam is brought into a certain box it remains locked up there*. In other words, the electron beam of the valve has the peculiar quality that it is attracted to an electrode having a certain voltage, but diverted from the same when the voltage is decreased or *increased*. This implies a negative slope in one part of the voltage-current characteristic of all the electrodes in the valve, that is, every electrode may under certain voltage conditions act as a negative resistance. The characteristic of an electrode is shown in Fig. 2, where AB represents a series resistance, giving the locking position C.

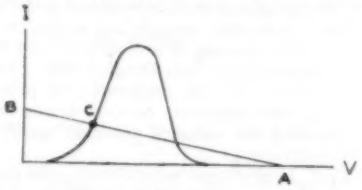

Fig. 2

The great flexibility of the trochoidal electron beam also makes it possible to use 'two-dimensional' electrode systems as in Fig. 3. If all electrodes except 0 are held at a high positive potential, the current goes to the plate 00. It may be switched, for example, to the plate 21 by putting the vertical guide 2 and the set of horizontal guides 1′ under zero voltage.

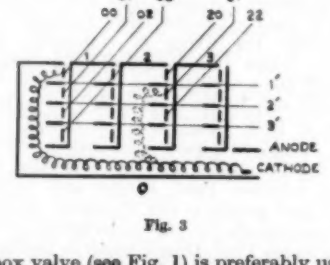

Fig. 3

A 10-box valve (see Fig. 1) is preferably used as an electrical counter ('scale-of-ten'). The pulses to be counted should be negative. They are applied to A, which is normally held at about 100 volts. Suppose that the beam at the beginning is landing on plate 4 in the first box. A decrease of the potential of this plate will displace the beam towards guide 5. Due to the resistance R in series with this electrode, the potential of 5 will immediately drop, so that the beam is brought into the second box. The next pulse will displace the beam from plate 6 to guide 7, which through a potential drop transfers the beam to the third box and so on. Finally, on arriving at guide 15, the beam is transferred to anode 2, and the anode potential will drop in the same way due to a series resistance, with the result that the emission from the cathode is cut off for a moment. Hence the initial conditions are restored so that the beam again goes to plate 4. Thus the valve may be operated as a cyclic switch. From the anode or one of the guides, every tenth of the input pulses may be tapped to another scale-of-ten unit or to a mechanical counter. Neon lamps in series with the plates may be used to indicate the actual position of the beam.

In this way the trochotron is used in electric counters and chronoscopes. It seems also to be a useful unit in calculating machines. A system for

pulse-time modulated multiplex telephony has also been worked out, in which the valve is used as a cyclic switch and modulator or demodulator simultaneously.

Detailed reports of the investigations are in preparation.

INDEXING PRACTICE: TRENDS IN GERMAN, AMERICAN AND BRITISH CHEMICAL SOCIETIES' PRACTICE

By R. BRIGHTMAN

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MOST organic chemists have found in literature searches that the tracing of entries relating to particular compounds may be difficult because of inconsistencies in indexing practice. For example, although in the introduction to the Collective Index 1923–32 to *British Chemical Abstracts* there is given a list of substituents such as amino-, chloro-, nitro-, etc., which in the Index are placed immediately after the remainder of the name, whether or not the substituent group is preceded by di-, tri-, etc., and although the name of the individual compound commences with that substituent, previous practice had varied. In earlier volumes "Nitrotoluene", for example, may be found under "Toluene, nitro-", "Nitrotoluene" or "Paranitrotoluene", with or without appropriate cross-references. Again, in one volume, "Nitrochloronaphthalene" appears as well as "Naphthalene-, nitrochloro", but "Tetranitronaphthol, α-", is given only under "T", whereas "Trichloroacetic acid" appears under "Acetic acid, trichlor-". Disregarding variations in spelling, "paranitroaniline" is indexed under "P" (Paranitroaniline), under "A" (Aniline, p-nitro-) and under "N" (Nitroaniline, p-), and the nitrotoluidines under "Aminotoluene, nitro", under "Nitro-toluidines", under "Toluene, nitroamino" and under "Toluidines, -nitro".

It is not surprising that consistency in indexing should grow slowly; and the present time may even be one of maximum confusion, due to the continual increase of potential morasses through the expansion of technical chemistry, as a comparison of college text-books of organic chemistry of the last thirty to forty years will illustrate. None the less, the present inconsistencies imply that, to be sure of finding all references to a chemical compound from the Indexes to the abstracts issued by the Chemical Society or the Society of Chemical Industry, one would require to scan the Indexes not only under the name of the present compound but also under all the possible variations in arrangement of parts of the name, and this without systematic guidance from the Index itself.

Such circumstances have induced a preliminary study of indexing practice of *British Chemical Abstracts*, the *Chemische Zentralblatt*, and *Chemical Abstracts*. In this study, the results of which are here presented, the comprehensiveness with which the literature is covered, questions of cost or other points of economics, interval between the appearance of the original paper and the abstract, and the qualifications of indexing staff, have not been considered. The prime purpose has been a comparison of the three systems in practice in regard to the indexing of chemical compounds, and, as a sample, the indexing of some typical compounds, namely, butadiene, the butylene glycols and ethylene glycol over the last fifty years was examined.

Ethylene Glycol

Chemische Zentralblatt. In the Index to the 1897 volume this compound is entered under "Glykol". "Äthylen Glykol" appears in the Collective Index for 1897–1901, but there is no cross-reference to or from "Glykol". A similar remark applies to the 1899 Index. In the 1900 Index, "Glykol" is used as a generic term. Separate entries appear under both names in the 1901 Index, while from 1905 onwards entries under "Glykol" are differentiated by formulæ. In 1906 and subsequent Indexes there is a cross-reference from "Glykol" to "Äthylen Glykol", but the Collective Indexes 1897–1921 contain entries under "Äthylenglykol" with a cross-reference "Glykol see Äthylenglykol". In the 1922–24 Collective Index this practice is reversed. Entries are placed under "Glykol (Äthylenglykol)" with an entry "Äthylenglykol—See Glykol", and in the 1925–29 Index the entries under "Glykol" are classified in the usual manner under "preparation, physical properties, chemical properties". Thereafter entries are consistently placed under "Glykol" with cross-reference "Äthylenglykol—See Glykol".

British Chemical Abstracts. The Indexes to the Chemical Society's *Abstracts* for 1897 and 1898 contain the entry "Ethylenic Glycol", and in 1899 there is the cross-reference "Glycol, see Ethylenic Glycol". During 1900–13 this becomes "Glycol. See Ethylene Glycol", and entries are placed under "Ethylene glycol". The latter term is the sole entry in the Indexes for 1915–17 and 1920–26, but in 1918 and 1919 the cross-reference "Glycol. See Ethylene glycol" is again given, and also in the Collective Indexes, 1903–12, 1913–22, 1923–32 and 1933–37 and the Annual Indexes to *British Chemical Abstracts* from 1927 onwards, with the exception of those for the years 1934–36 and 1943–44, when the cross-reference from "Glycol" is dropped although the entries are still placed under "Ethylene glycol".

Chemical Abstracts. In the Indexes to the 1907–9 volumes there are entries under "Ethylene glycol" and "Glycol" with no cross-reference. In 1910 there are entries under "1 : 2-Glycol" but none under "Ethylene glycol". In 1911 "Glycol" only is entered, and in the following year both "Ethylene glycol" and "Glycol" appear without cross-reference: the entries under "Glycol" in this year (1912) relate to derivatives. Entries in 1913 and 1914 are similar, but in 1915 under "Glycol" there is entered "See also Ethylene Glycol". In 1918 under "Glycol" is entered the note: "Individual glycols not having a common name, e.g., glycol, are indexed under the Geneva name, e.g., Propanediol". This note is repeated in 1919 and afterwards. The same volumes contain the entry "Ethylene glycol. See Glycol. For derivatives see 1 : 2-Ethanediol, 1 : 2-Propanediol, etc.", and this is repeated at intervals down to 1944.

Butylene Glycol

The indexing of butylene glycol in the period 1901–44 presents a similar picture. In the *Chemische Zentralblatt*, entries are made both under "Butylen glykol" and "Butandiol", and only in 1919 is there a cross-reference "See Butylen glykol" under "Butandiol". But from 1922 onwards entries under

"Butandiols" and "Butylen glykols" are transferred to the Formula Index.

In *British Chemical Abstracts* and *Chemical Abstracts*, entries are made both under "Butylene glycol" and "Butane diol", frequently without cross-reference; and although the tendency in *Chemical Abstracts* from 1918 onwards is to enter under "Butane diol" in accordance with the note already quoted under "Ethylene glycol"—"Individual glycols not having a common name, e.g., glycol, are indexed under the Geneva name, e.g., Propanediol"—the Index to the volume for 1920 contains the entry "Butane diol. See Butylene glycol".

Butadiene

Chemische Zentralblatt. "Butadiene" first appears under that name in the 1897–1901 Collective Index. The Index to the volume for 1903 contains an entry under "Erythren" but nothing under "Butadiene". In the 1902–6 Collective Index all three names, "Butadiene", "Erythren" and "Divinyl", are entered, but there are no cross-references. There is a reference under "Erythren. See Divinyl" in the 1911 Index, but "Butadiene" is entered separately with no cross-reference. In the index to the second volume for the same year, "Butadiene" and "Erythren" are entered separately with no cross-reference or to "Divinyl". In 1912 there is an entry under "Erythren" and a cross-reference "Butadiene. See Erythren". In 1913 "Divinyl" and "Erythren" are entered separately for the first half-year, and in the second half-year there are entries "Butadiene" and "Erythren" but with no entry for "Divinyl". The Indexes for 1914 and 1915 contain entries for "Butadiene" and "Erythren" but no cross-reference; and in 1916 there are entries under "Divinyl" and "Erythren" but not under "Butadiene", and there are no cross-references. Similarly, the entries in 1918 under "Divinyl" and "Butadiene" are without cross-references; and also in 1919 under "Butadiene" and "Erythren" and in 1921 under "Butadiene". The 1912–15 Collective Index refers from "Butadiene" to "Erythren" and *vice versa*, but there is no reference from either to "Divinyl", which is entered without a cross-reference. In the 1917–21 Collective Index, "Divinyl" and "Erythren" are both entered without cross-reference and there is no entry under "Butadiene". In the following Collective Index (1922–24) there are entries "Erythren. See C_4H_6", "Butadiene. See C_4H_6", but there is no entry under "Divinyl". In the next Collective Index (1925–29) all three names are referred to the Formula Index.

British Chemical Abstracts. Much the same variations are found in the *Abstracts* of the Chemical Society and in *British Chemical Abstracts*. In 1899 the entry "Divinyl. See Butinene" occurs, while "Butinene (Divinyl)" is also entered. In 1901 the following entries are made:

"Butinene (Ethylacetylene),
Butinene (Crotonylene, dimethylacetylene)";

but there is none under "Butadiene", "Divinyl" or "Erythrene". "Butadiene" appears in 1904, and in 1905 in addition to "Butadiene" and "Erythrene" there is the entry "Butinene. See Erythrene". "Butadiene" alone is entered in 1906, "$\Delta^{\alpha\gamma}$-Butadiene" in 1907, "n-Butinene" in 1909, and "Butadiene" and "Erythrene" in 1912. In 1913 there are the following entries: "Erythrene", "$\Delta^{\alpha\gamma}$-Butadiene", "Δ^{α}-Butinene", "Δ^{β}-Butinene. See Crotonylene". In 1914 there are entries for "Butadienes", "$\Delta^{\alpha\gamma}$-Butadiene", "Δ^{α}-Butinene" and "Erythrene" but no cross-references; in 1915 "Butadiene"; in 1916 "Divinyl" and "Erythrene" (without cross-reference); in 1917 "Divinyl"; and in 1923 "Butadienes" only. In 1924 "Butadiene", and "Δ^{γ}-Butinene $CH_3 : CH.CH : CH_2$" are entered, while the Collective Index 1923–32 gives "Butadiene", "$\Delta^{\alpha\beta}$-Butadiene", "$\Delta^{\alpha\gamma}$-Butadiene", "Butadienes", "Erythrene (See also Hydrocarbons, erythrene)", "Divinyl"; but without other cross-references. The Collective Indexes, 1903–12 and 1913–22, similarly give all three terms without cross-references. Similar inconsistencies persist in the annual indexes down to 1940. Some years one term is used and in others another, with no cross-reference in either volume. For example, in 1926, both "Butadiene" and "Erythrene" appear; in 1930 "Butadiene" and "Divinyl"; while in 1934 all three are entered. "Divinyl" appears again in 1937 and 1938, but not afterwards. "Erythrene" is only entered again in 1939 and thereafter entries are under "Butadiene" or "$\Delta^{\alpha\gamma}$-Butadiene", but without cross-references.

Chemical Abstracts. "Butadiene" first appears in the Index to *Chemical Abstracts* in 1911, and in 1912 "Butadiene", "Divinyl" and "Erythrene" are all entered. In 1913 "Butadiene" and "Erythrene" are entered; all three appear in 1914 and 1915; but not until 1916 are there cross-references, when "Divinyl" is made the main entry and "Erythrene" and "Butadiene" are entered with the note "See Divinyl".

This practice, however, was not adhered to rigorously, for in 1918 there are entries under "Butadiene" but not under "Erythrene" or "Divinyl", and the entry "Bivinyl" and the cross-reference "Butadiene. See Bivinyl" do not appear until 1921. In 1922 "Butadiene" and "Divinyl" are entered, but not "Bivinyl" or "Erythrene". In 1923 "Butadiene. See Bivinyl" is again entered, but the only entry under "Erythrene" is "Erythrene, αx-dimethyl—See 1 : 3-Pentadiene, 4-methyl-". In 1925 there is the entry: "Bivinyl (erythrene) (for derivatives, see under 1 : 3-butadiene, etc.)" and also "Erythrene, see Bivinyl", both of which are repeated in 1926. The entry "Divinyl, see Bivinyl" is not repeated in 1926, although this volume includes the entry "1 : 3-Butadiene, see Bivinyl".

The indexing appears to become more systematic from 1927 onwards, though the editors appear to be unable to make up their minds which name to adopt as the main entry. Thus in 1927 we find "1 : 3-Butadiene, see Bivinyl"; "Erythrene, see Bivinyl"; "Bivinyl (Erythrene). For derivatives see under 1 : 3-Butadiene, etc.", and in 1928 "Divinyl, see Bivinyl". In 1931, however, there are no entries under "Divinyl" and "Erythrene", and under "Bivinyl" is entered "see 1 : 3-Butadiene". There are no cross-references from "Butadiene". Again, although in 1934 and 1935 "Bivinyl" is entered "see Butadiene", and "Butadiene (bivinyl)", there are no entries or cross-references for "Divinyl" and "Erythrene". In 1937 there is entered "Bivinyl (Erythrene), see also Butadiene"; "1 : 3-Butadiene, see also Bivinyl"; "Divinyl, see Bivinyl"; "Erythrene, see Bivinyl". In 1938 "Bivinyl" is entered "see 1 : 3-Butadiene"; but although bivinyl is given in brackets after "Butadiene", there are no entries under erythrene or divinyl. In 1941 "Butadiene" is entered "See also Di- under Olefins" and "Olefins, di-", "See also Rubber substitute and synthetic". In 1942–44 butadiene is entered "Butadiene (Bivinyl).

See also Rubber substitute and synthetic" and in "Di-" under "Olefins".

These examples indicate that while cross-referencing in the indexes to *Chemical Abstracts* is no more systematic than in *British Chemical Abstracts*, it is somewhat more complete. What is more impressive, however, when the indexes are compared, is the extent to which the editors of *Chemical Abstracts* have from the start attempted to define precisely the indexing policy followed and to modify this from time to time to incorporate any practice on which some general international agreement has been reached. For example, in 1938–40 the nomenclature and indexing for inorganic compounds was modified in accordance with the recommendations of the report of the German Commission (*Helv. Chim. Acta*, **20**, 159; 1937) and the rules of the Commission on the Reform of the Nomenclature of Inorganic Compounds (*Ber.*, **73A**, 53; 1940; *J. Chem. Soc.*, 1404; 1940); while in 1935 Crane's modified Broughton system was brought into use for deuterium compounds (*Ind. Eng. Chem., News Ed.*, **13**, 200; 1935). In the 1938 Index the practice used in botanical and zoological nomenclature is also defined, and the authorities used for insects, for bacteria, and for alloys are specified.

The practice followed in indexing organic compounds is described in detail in prefaces to the indexes to successive volumes, notably in those for 1917, 1927, 1937 and 1945, and the Collective Indexes for 1907–16 and 1917–26. The basis of this has been the system of organic chemical nomenclature described by A. M. Patterson and C. E. Curran (*J. Amer. Chem. Soc.*, **19**, 1623; 1917), and the most striking change in the indexing methods is the inversion of all names containing substituent prefixes, "Chloroacetic acid", for example, being now placed under "Acetic acid, chloro-". This is in keeping with the principle laid down in the preface to the 1918 volume that subjects, not words, are indexed; but the idea of arranging alphabetically on the basis of the parent compound was taken from the *Journal of the Chemical Society*, although it was not until the 1923–32 Collective Index that the practice was systematically adopted in *British Chemical Abstracts*. Afterwards, in 1937, some changes were made towards the adoption of the Rules given in the Definitive Report of the International Committee on Organic Nomenclature (*J. Chem. Soc.*, 1607; 1931; *J. Amer. Chem. Soc.*, **55**, 3905; 1933; cf. also C. Smith, *J. Chem. Soc.*, 1067; 1936). Although there is nothing to indicate the fact in prefaces to *Chemical Abstracts* or *British Chemical Abstracts*, according to a paper by E. J. Crane (*J. Chem. Educ.*, **8**, 1335; 1931) in 1923 the Nomenclature Committee of the Chemical Society, London, and that of the American Chemical Society, agreed on the rules covering some of the more commonly disputed points, including some of significance for classification.

In contrast to this it is difficult to trace definite evidence that any of these reports on organic or inorganic nomenclature or on the nomenclature of deuterium compounds have been adopted in British practice. Apart from a brief preface to the Collective Indexes for 1883 and 1892, according to which the index is in the main alphabetical, but wherever practicable substances are arranged alphabetically and under such well-defined main groups as alkaloids, carbohydrates, glucosides, etc., there is no further preface or explanatory note until the Collective Index for 1923–32, when the practice already noted of placing certain substituent groups after the remainder of the name is adopted. Some indication as to indexing practice may be found in the "Instructions to Abstractors" which are sometimes to be found bound with the *Abstracts*, although I have not been able to trace an issue earlier than 1918. Much of this, and indeed the use as standard of reference of the Collective Indexes of the Chemical Society, 1913–22 and 1923–32, involves the translation of names used in American and other chemical periodicals, to fit rather a set of rules than a defined system or set of principles.

From this preliminary survey certain tentative conclusions can be drawn.

(1) *Chemical Abstracts* represents the most persistent attempt to provide adequate alphabetical indexing of chemical compounds by name; but even in current practice, room for considerable improvement can be seen.

(2) Both in *Chemical Abstracts* and in *Chemische Zentralblatt* there can be seen a distinct trend towards a formula index for indexing definite organic chemical compounds, in view of variations in chemical nomenclature and to allow for compounds not named by their originators.

(3) There is some evidence of a trend towards agreement on nomenclature between the British and American Chemical Societies, but progress in this direction is unlikely to be rapid and the general adoption of an international system by all chemists is a remote probability, even disregarding the fundamental difference of mother tongues.

(4) Independently of the question of coverage and of the economic aspects of abstracting, on the basis of circulation and resources, it is now improbable that *British Chemical Abstracts* could ever hope to compete with *Chemical Abstracts*; nor has this survey revealed any reason for making the attempt.

(5) The law of scattering deduced by the late Mr. E. Lancaster-Jones in an investigation instigated by Dr. S. C. Bradford (cf. *Engineering*, **137**, 85; 1934; also *Rep. Proc. 14th Conf. Assoc. Spec. Lib. and Inform. Bur.*, 1937, pp. 59–71; and *F.I.D. Comm.*, **13**, 61–65; 1946) suggests that the best means of securing complete cover is not by rival abstracting organisations, but by functional co-operation and laying out the field by sciences on some such basis as the Universal Decimal Classification.

The most important development to be desired appears to be the standardization of indexing practice, probably on the basis of formulæ rather than names, and the establishment of some central body with adequate resources to provide comprehensive annual and decennial, or other periodic indexes, as may be most convenient, for English-speaking chemists. Since reports from Germany (cf. *Ind. Eng. Chem., News Ed.*, **24**, 790; 1946) suggest that the future of the *Chemische Zentralblatt* is highly uncertain, this appears to be the most urgent need and much more essential than the question of abstracting. If any financial resources can be set free for the purpose by elimination of redundant abstracting, that might strengthen the case for Government assistance if required. Since, however, the provision of such comprehensive indexes would be of great assistance to industrial research in particular, it should not be difficult to make out a strong case in the first instance for support by industry as well as by the State.

ROYAL PHOTOGRAPHIC SOCIETY'S EXHIBITION

THE ninety-second annual exhibition of the Royal Photographic Society has this year, for the first time, been held in two sections on view at different times. It will be recalled that last year the whole exhibition was displayed in a gallery at the Science Museum, London, at the same time as the special exhibition commemorating the centenary of photography. This year the exhibition has returned to the Society's House at 16 Prince's Gate, London, S.W.7, and the experiment has been tried of division in time to permit both sections more space. Part 1, which was pictorial in outlook, was shown first, and was followed by Part 2, which had a scientific outlook. The lantern slides, colour transparencies and stereoscopic exhibits, most of which belonged to Part 1, were shown for the whole period of the exhibition.

The scientific section was as usual dominated by the natural history exhibits, which are well up to standard in quality as well as quantity. By far the majority of exhibits are photographs of birds in their natural surroundings, and we can but admire the ingenuity and patience that enables the photographer to approach such timid creatures sufficiently closely to produce such fine photographs. Two exhibitors received the Society's Medal for their entry. High-speed flash photography has been used to produce some remarkably interesting records of birds in flight. A redstart is photographed in various attitudes when approaching to alight on a twig and illustrates well the use of the wings as a brake. Perhaps the most remarkable high-speed photograph is that of a tawny owl flying towards the camera with a mouse in its beak. The movement has been arrested and the bird is in perfect focus, though it can be seen from the ground that the depth of field is relatively small. One wonders whether this was secured by perfect timing or whether some tripping device was used. Of all the exhibits, which in addition to birds included insects and flowers, it may be said that most of them, as well as providing a record, have artistic merit of their own and can be enjoyed by the physicist and chemist as well as by the ornithologist and botanist.

The next largest entry was in the so-called Record Press and Commercial Section. This always seems a little out of place among the scientific and technical exhibits, consisting, as it invariably does, mainly of photographs of carvings in churches, abbeys and other ancient buildings. However, recent experience during the years of destruction should have taught us the great value of records of the kind shown, and if such recording could be placed on a firmer scientific foundation, the results would be of even greater value.

The Scientific Section was quite well represented, but one cannot help comparing it unfavourably with the display at the Science Museum last year. There were forty-four exhibits, mainly photomicrographs. Of special merit was the exhibit awarded the Rodman Medal, illustrating in a series of six photomicrographs the development of the brittle starfish (*Ophiothrix fragilis*). The following is an extract from the catalogue: "It is believed that this is the first time that the development of a brittle-star has been illustrated by photography of the living larvæ. The various stages were obtained from the plankton, transferred to filtered sea water and photographed, without narcotization, under dark-ground illumination, a variety of objectives and eyepieces being used. Exposures were generally about one-fifth of a second."

There was an interesting series of photographs of triangular markings on the natural surface of a diamond crystal. These markings are often deep with steep sides, and the series consists of photomicrographs illustrating the patterns produced with the crystal surface in contact with an optical flat. The depth and contour of the sides of the hollow can be better interpreted by the use of unfiltered mercury light than by monochromatic light. The high-speed exhibit, which has for years introduced something new and interesting, was disappointing, though it contained one of the most remarkable pictures in the whole exhibition. It is entitled "Milk Bar" and was photographed during a milking operation when a fine jet of milk was directed horizontally. This jet of milk was incident normally on the end of a cat's nose, the cat having reared up on its haunches in order to reach the stream. The expression on the cat's face defies description. This photograph was submitted in this section on the somewhat ingenuous excuse that it illustrates the fact that the jet of milk is divided into droplets. Whatever we may say on the subject of suitability of subject-matter, no human selection committee could possibly have rejected this photograph.

Finally, in order of number of exhibits, came the Medical Section. This contained sixteen exhibits including the 'before and after' type illustrating the results of plastic surgery, photographs of surgical specimens, and clinical photographs.

STANDARDIZATION IN INDUSTRY

"THE History and Philosophy of Standardization" might serve as a descriptive title for the main theme of the presidential address of Mr. Percy Good delivered before the Institution of Electrical Engineers on October 9.

From the simple beginnings with weight, length and volume standards already recognized in antiquity as necessary concomitants of trade in and between civilized communities we have erected, in modern times, a vast and complex structure of standards and codes of practice to meet our present-day needs. "Just as it became necessary", said Mr. Good, "from the earliest trading days to have standards for comparing or measuring quantity so, to-day, when in a very large number of cases weight, area or volume have no significance in determining the suitability or value of a product, standards are required to enable the properties which are significant to be assessed in comparable terms." The industrial standards employed to-day comprise the following classes: standards of quality, fitness for purpose or performance; dimensional standards; standard methods of sampling, and certification marking; terms, definitions and symbols (nomenclature).

Referring to dimensional standards, which have as a primary purpose the securing of interchangeability and the establishing of a range of types, experience during the War provided instances in which requirements could be met by types numbering perhaps dozens where hundreds or even thousands of types had previously been manufactured. Each industry should investigate the economics of dimensional

standardization from the points of view of interchangeability and the elimination of unnecessary types and sizes. Commenting upon the refusal of the English-speaking countries to abandon completely the traditional and instinctive methods of subdivision in favour of the metric system, Mr. Good remarked: "This characteristic compromise is due partly to an intuitive recognition that there is much reason behind tradition and partly to an intuitive selection from alternatives of the one which most facilitates thinking processes. It perhaps also illustrates an unconscious resistance to the view that the scientist is always right and should have the last word."

Assessment of the quality of a commodity in bulk by the process of sampling is an inheritance from early trading practice which only in recent years has been developed and applied in manufacturing industry on a sound scientific basis. This development has rendered practicable the use of certification marks on goods where testing must, for one reason or another, be carried out on samples. A notable example of the successful use of a certification mark, in association with a manufacturer's mark, is the hall-marking of gold and silver articles, a practice introduced in Britain more than six hundred years ago.

The standardization and the co-ordination of the technical terms employed in science and in industry are not inconsiderable factors in the conduct of trade with efficiency and probity. The possibility of international as well as national co-operation in the introduction and definition of new technical and scientific terms is, in Mr. Good's opinion, a matter meriting the attention of the Institution of Electrical Engineers.

In the development of electrical standards, the work of the British Association in 1861 on the fundamental units was followed by the setting up in 1885 of a committee of the Institution of Electrical Engineers to prepare standards for electrical materials and appliances. This Committee was, shortly after the turn of the century, to merge its activities with those of the standardizing committees of the other professional engineering institutions in Britain to form the organisation now known as the British Standards Institution. From its inception as a body concerned with engineering standards, this body has developed into an organisation embracing within its scope practically every form of industrial activity and enabling all sections of industry to co-operate in the preparation of standards. The ideal standard should include requirements in terms of the mechanical, physical and chemical properties which can be assessed objectively; but many of our present standards necessarily include estimations of a subjective character. The progressive elimination of such indefinite measures of quality or performance is one of the important branches of research in relation to standardization.

Reviewing the position of the electrical industry as a whole, Mr. Good remarked that he had watched its growth first from the inside and later from an external position in which he had been able to compare progress with that of other industries. "As a result", he said, "I am convinced of the truth of S. Z. de Ferranti's statement, made in 1910 and referred to in last year's presidential address, that wherever coal or gas is used for the production of heat or power, everything for which it is used would be better done were electricity the medium of application." That there will be an enormous increase in the use of electricity is certain. The electrical industry in Britain is, however, in common with others, faced with the need for planning for its future development. "This year", he went on, "has seen an Act of far-reaching importance come into being. In my opinion there is no substantial case against some form of public control of the generating and distribution side of the electrical industry, nor indeed against national control of any public service where competition is unwarrantable. This section of the industry should, however, be confined to generating and distribution and should not be permitted to manufacture the machinery or equipment it uses. A very different type of mind is required for the generating and distribution side than is required for the manufacturing side, for those responsible for running machinery and equipment have to be satisfied with it for many years, whereas the maker should be temperamentally desirous of improving his product. Moreover, a great deal of technical progress is made as a result of what might be called the 'competition' that goes on in the designer's mind in his desire to make progress."

"We are", said Mr. Good, in concluding this section of his address, "inheritors of the result of the thinking of our predecessors, and we must see to it that when our successors look back they do not detect any flagging in our efforts to give humanity the benefits that electricity alone can bring."

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, November 3

ROYAL SOCIETY OF MEDICINE, EPIDEMIOLOGY AND STATE MEDICINE SECTION (at 1 Wimpole Street, London, W.1), at 4.30 p.m.—Dr. E. Ashworth Underwood: "History of Cholera in Great Britain"; Major-General Sir John Taylor: "Current Problems in Cholera Control"; Mr. P. Bruce-White: "Bacteriological and Immunological Aspects of Cholera".

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY (in the Reynolds Hall, College of Technology, Manchester), at 5.30 p.m.—Symposium on "Intelligence Testing in School and Work".*

SOCIETY OF ENGINEERS (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. R. C. Smart: "Industrial Organisation as a Factor in Production Efficiency".

TEXTILE INSTITUTE (at 16 St. Mary's Parsonage, Manchester), at 6 p.m.—Mr. A. Walton: "The Artist in Relation to Textiles".

Tuesday, November 4

ROYAL ANTHROPOLOGICAL INSTITUTE (at 21 Bedford Square, London, W.C.1), at 5 p.m.—Hon. Camilla Wedgwood: "Trading and the Exchange of Goods on Manam Island".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5.15 p.m.—Sir Edward Salisbury, F.R.S.: "The Vegetation of the Chalk", 2. "The Biological Features of the Chalk Down Flora and their relation to the Physical and Biotic Factors".

CHEMICAL ENGINEERING GROUP (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. L. Rotherham: "The Selection of Stainless Steels for the Chemical Engineering Industries".

INSTITUTE OF PHYSICS, ELECTRONICS GROUP (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. J. H. Pratt: "Infra-Red Image Converters".

INSTITUTION OF CIVIL ENGINEERS (at Great George Street, London, S.W.1), at 5.30 p.m.—Sir Roger Hetherington: Presidential Address.

INSTITUTION OF MECHANICAL ENGINEERS, AUTOMOBILE DIVISION (at Storey's Gate, St. James's Park, London, S.W.1), at 6 p.m.—M. A. Jullien: "Independent Suspension Systems".

SHEFFIELD METALLURGICAL ASSOCIATION (joint meeting with the IRON AND STEEL INSTITUTE, at 198 West Street, Sheffield), at 7 p.m.—Mr. C. Sykes, F.R.S., Mr. H. H. Burton and Mr. C. C. Gegg: "Hydrogen in Steel Manufacture"; Prof. J. H. Andrew, Mr. H. Lee, Mr. H. K. Lloyd and Mr. N. Stephenson: "Hydrogen and Transformation Characteristics in Steel".

Wednesday, November 5

INSTITUTE OF FUEL (at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1), at 2.30 p.m.—Mr. Donald Hicks: "The Coal Resources of the Country".*

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Sir Harry Lindsay: "Cultural Relations within the British Commonwealth".

INSTITUTION OF ELECTRICAL ENGINEERS, RADIO SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Dr. G. D. Reynolds: "Tests for the Selection of Components for Broadcast Receivers".

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6 p.m.—Scientific Papers.

MANCHESTER METALLURGICAL SOCIETY (at the Engineers' Club Albert Square, Manchester), at 6.30 p.m.—Mr. E. Jones: "Electrical Strain Gauges".

ROYAL STATISTICAL SOCIETY, BIRMINGHAM GROUP OF THE INDUSTRIAL APPLICATIONS SECTION (in the Chamber of Commerce, 95 New Street, Birmingham), at 6.30 p.m.—Mr. L. T. Wilkins: "Methods of Forecasting and Preventing Accidents".

INSTITUTE OF WELDING, MANCHESTER AND DISTRICT BRANCH (in the Reynolds Hall, College of Technology, Manchester), at 7 p.m.—Mr. H. E. Lardge: "Welding in the Development of Jet Propulsion Engines".

SOCIETY OF INSTRUMENT TECHNOLOGY (joint meeting with the SOCIETY OF GLASS TECHNOLOGY, in the Lecture Theatre, Science Museum, South Kensington, London, S.W.7), at 7 p.m.—Discussion on "The Instrumentation of Glass Tank Furnaces" (to be opened by Mr. R. L. Crooks and Mr. C. H. Stone).

Thursday, November 6

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Special General Meeting to consider a proposal by Council for the alteration of Statute 23; Dr. H. R. Ricardo, F.R.S.: "Some Problems in connexion with the Development of a High-speed Diesel Engine" (Bakerian Lecture).

MINERALOGICAL SOCIETY (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Scientific Papers.

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. C. N. Cock: "Electric Traction on the Southern Railway".

CHEMICAL SOCIETY (in the Chemistry Lecture Theatre, University College, Nottingham), at 6 p.m.—Prof. F. S. Spring: "Some Contributions of the Organic Chemist to Biological Science".

ILLUMINATING ENGINEERING SOCIETY, MANCHESTER CENTRE (joint meeting with the NORTH-WESTERN BRANCH OF THE INSTITUTION OF ELECTRONICS, in the Reynolds Hall, College of Technology, Manchester), at 6.30 p.m.—Dr. J. N. Aldington: "The Evolution of an Electric Lamp".

CHEMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 7.30 p.m.—Scientific Papers.

ROYAL INSTITUTE OF CHEMISTRY, LONDON AND SOUTH-EASTERN COUNTIES SECTION (at the South-West Essex Technical College, Forest Road, Walthamstow, London, E.17), at 7.30 p.m.—Scientific Film Display.

CHEMICAL SOCIETY (in the Chemical Department, The University, Woodland Road, Bristol).—Prof. R. D. Haworth, F.R.S.: "The Oxidation of Phenols".

Friday, November 7

ASSOCIATION OF APPLIED BIOLOGISTS (in the Botany Lecture Theatre, Imperial College of Science, South Kensington, London, S.W.7), at 2.15 p.m.—Dr. C. Evans: "The Biology of Earthworms and their Effects on the Soil".*

BEDSON CLUB (in the Chemistry Lecture Theatre, King's College, Newcastle-upon-Tyne), at 5.30 p.m.—Prof. H. Bassett: "Pages from the Chemistry of Aluminium" (Sixty-seventh Bedson Lecture).

INSTITUTION OF ELECTRICAL ENGINEERS, MEASUREMENTS SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Discussion on "Telephone Cable Measurements" (to be opened by Mr. S. Hanford).

INSTITUTION OF MECHANICAL ENGINEERS (at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Discussion on "The Measurement of the Temperature of Sliding Surfaces, with particular reference to Railway Brake Blocks" (to be opened by Dr. R. C. Parker and Dr. P. R. Marshall).

ROYAL STATISTICAL SOCIETY, LONDON GROUP OF THE INDUSTRIAL APPLICATIONS SECTION (joint meeting with the INSTITUTION OF ENGINEERING INSPECTION, at the E.L.M.A. Lighting Service Bureau, 2 Savoy Hill, London, W.C.2), at 6 p.m.—Mr. D. Newman: "Acceptance Inspection with special reference to Sequential Methods".

GEOLOGISTS' ASSOCIATION (at the Geological Museum, Exhibition Road, London, S.W.7), at 6.30 p.m.—Annual Re-Union.

OIL AND COLOUR CHEMISTS' ASSOCIATION, MANCHESTER SECTION (at the Engineers' Club, Albert Square, Manchester), at 6.30 p.m.—Discussion on "Surface Activity".

SOCIETY OF CHEMICAL INDUSTRY, MANCHESTER SECTION (at the Engineers' Club, Albert Square, Manchester), at 6.30 p.m.—Prof. E. C. Dodds, F.R.S.: "Academic Research and the Chemical Industry".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 9 p.m.—Prof. E. K. Rideal, F.R.S.: "Foam".

CHEMICAL SOCIETY (joint meeting with CAMBRIDGE UNIVERSITY, in the Univer ity Chemical Laboratory, Cambridge).—Prof. C. N. Hinshelwood, F.R.S.: "A Problem in Chemical Kinetics".

Saturday, November 8

PHYSICAL SOCIETY (in the Physics Department, University College, Nottingham), at 10 a.m.—Scientific Papers.

INSTITUTION OF CHEMICAL ENGINEERS, NORTH-WESTERN BRANCH (in the Reynolds Hall, College of Technology, Manchester), at 3 p.m.—Mr. A. L. Curtis: "Modern Tar Distillation Plant".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

LABORATORY STEWARD to take charge of the maintenance of the teaching and research laboratories of the Chemistry Department—The Bursar, The University, Sheffield (November 8).

LECTURER IN CHEMISTRY (Ref. F.886/47A), and a LECTURER IN PHYSICS (Ref. A.391/47A), at the Royal Aircraft Establishment, Technical College, Farnborough—The Ministry of Labour and National Service, Technical and Scientific Register, Room 669, York House, Kingsway, London, W.C.2, quoting the appropriate Ref. No. (November 8).

PRINCIPAL OF THE LUTON TECHNICAL COLLEGE—The Director of Education, Shire Hall, Bedford (November 8).

LECTURER IN MECHANICAL ENGINEERING—The Principal, Brighton Technical College, Brighton 7 (November 8).

TEACHER IN BIOLOGY at Canterbury Technical College and County Technical School for Boys—The Education Officer, 78 London Road, Canterbury (November 8).

SCHOOL PSYCHOLOGIST—The Director of Education, Education Department, Pontmorlais, Merthyr Tydfil (November 8).

LECTURER IN MATHEMATICS, and a LECTURER IN CHEMISTRY, at the North Gloucestershire Technical College—The Clerk to the Governors, The Lypiatts, Lansdown Road, Cheltenham (November 8).

SENIOR RESEARCH OFFICERS (2) with the Social Survey Division of the Central Office of Information—The Ministry of Labour and National Service, Appointments Department, Technical and Scientific Register, Room 669, York House, Kingsway, London, W.C.2, quoting G.471/47A (November 10).

PRINCIPAL OF THE TECHNICAL COLLEGE to be established in Chippenham—The Director of Education, County Hall, Trowbridge, Wilts, endorsed 'Chippenham Technical College' (November 10).

AGRICULTURAL ECONOMIST, and ASSISTANT AGRICULTURAL ECONOMISTS (2, Grade B), to work under the direction of the Provincial Agricultural Economist at Newton Abbot—The Registrar, The University, Bristol 8 (November 10).

RESEARCH CHEMIST for work on soils, with headquarters at Auchincruive—The Secretary, West of Scotland Agricultural College, Blythswood Square, Glasgow C.2 (November 14).

ASSISTANT LECTURERS IN THE DEPARTMENT OF PHYSIOLOGY (one will be mainly concerned with HISTOLOGY)—The Registrar, The University, Liverpool (November 15).

RESEARCH FELLOW to work in the field of intermetallic friction under conditions of plastic deformation in metal-working processes—The Professor of Industrial Metallurgy, The University, Edgbaston, Birmingham 15 (November 15).

RESEARCH OFFICERS (2) IN THE DIVISION OF ELECTROTECHNOLOGY, Sydney—The Secretary, Australian Scientific Research Liaison Office, Australia House, Strand, London, W.C.2, quoting No. 1402 (November 22).

PRINCIPAL SCIENTIFIC OFFICER OR ENGINEER I at the National Gas Turbine Establishment under the Ministry of Supply—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2027 (November 28).

LECTURER or ASSISTANT LECTURER IN ZOOLOGY (preferably with special knowledge or qualifications in Vertebrate Zoology)—The Registrar, University College, Southampton (November 30).

PRINCIPAL SCIENTIFIC OFFICER in the Armament Design Department (Unguided Rocket Design Group), a PRINCIPAL SCIENTIFIC OFFICER in the Armament Design Department (Central Technical Group), and a PRINCIPAL SCIENTIFIC OFFICER or SENIOR SCIENTIFIC OFFICER in the Armament Research Department, under the Ministry of Supply—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2024 (December 5).

ELECTRICAL ENGINEERS FOR THE ELECTRICITY DEPARTMENT of the Malayan Union—The Director of Recruitment, Colonial Service, 15 Victoria Street, London, S.W.1.

SENIOR LECTURER IN AGRICULTURE, and a RESIDENT ASSISTANT LECTURER IN AGRICULTURE, at the Cumberland and Westmorland Counties' Farm School, Newton Rigg—The Director of Education, 5 Portland Square, Carlisle.

SENIOR ASSISTANT LECTURER IN THE DEPARTMENT OF MECHANICAL ENGINEERING—The Principal, Borough Polytechnic, Borough Road, London, S.E.1.

LECTURERS IN (*a*) CHEMISTRY to B.Sc. standard, (*b*) PHYSICS to General Degree standard—The Clerk, Northern Polytechnic, Holloway, London, N.7.

GRADUATE ASSISTANT MASTER FOR PHYSICS, with subsidiary Chemistry and Mathematics, at the County Technical School—The Director of Education, County Education Offices, Newtown, Montgomeryshire.

LECTURER IN ECONOMIC THEORY, and an ASSISTANT LECTURER IN PSYCHOLOGY—The Registrar, University College, Nottingham.

FISHERIES RESEARCH OFFICER (male or female) in Uganda—The Director of Recruitment, Colonial Service, 15 Victoria Street, London, S.W.1.

HISTOLOGIST, an EMBRYOLOGIST, a NEUROANATOMIST, and a PROFESSOR OF PHYSIOLOGY—The Medical Secretary, Hebrew University, Jerusalem, Palestine.

SENIOR NUTRITIONIST or DIETIST, and LABORATORY TECHNICIANS (including animal attendants)—The Director, Wellcome Laboratory of Human Nutrition, Churchill Hospital, Oxford.

TECHNICIAN to take technical charge of laboratory and the training of junior technicians—The Secretary, Bacterial Chemistry Research Unit, Lister Institute, Chelsea Bridge Road, London, S.W.1.

RESEARCH WORKER for investigation on African Trypanosomes at Field Station near St. Albans—The Director, Department of Parasitology, London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1.

RESEARCH ASSISTANT with qualifications in physiology or zoology, at the Gerontological Research Unit—Dr. Korenchevsky, University Museum, Oxford.

VICE-PRINCIPAL (woman, with qualifications in Education or Psychology), and a LECTURER (part-time, man or woman) IN BIOLOGY—The Principal, City of Leicester Training College, Humberstone Drive, Leicester.

MECHANICAL ENGINEER in the Public Works Department, Tanganyika Territory—The Director of Recruitment, Colonial Service, 15 Victoria Street, London, S.W.1.

EXECUTIVE ENGINEER for the Public Works Department, Nigeria—The Director of Recruitment, Colonial Service, 15 Victoria Street, London, S.W.1.